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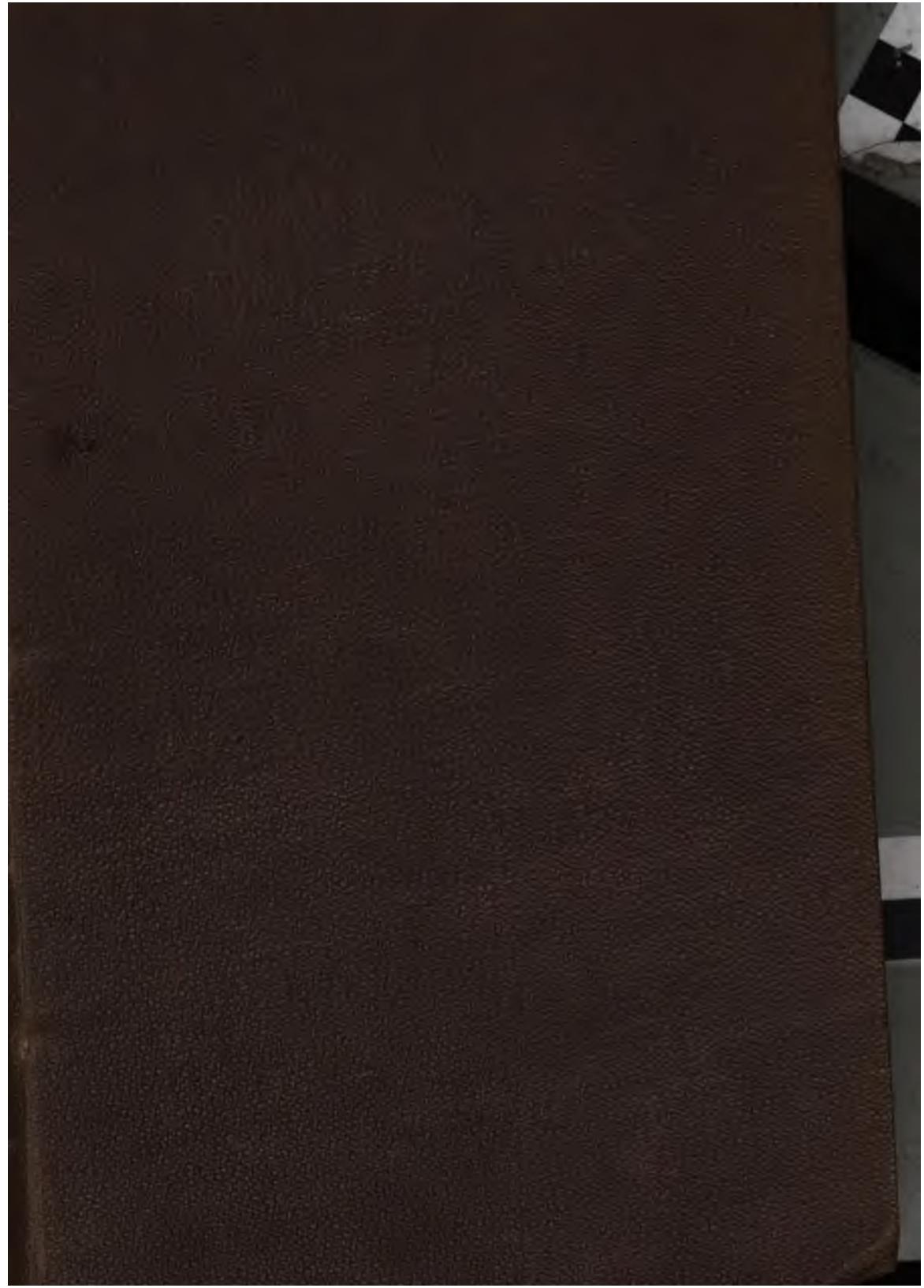
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1

Proceedings
of the
Philosophical Society
of Glasgow.





HENRY MUIRHEAD, M.D. L.L.D. &c.
PRESIDENT OF THE PHILOSOPHICAL
SOCIETY OF GLASGOW.

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PROCEEDINGS
OF THE
PHILOSOPHICAL SOCIETY OF GLASGOW.

EIGHTY-THIRD SESSION, 1885-86.

I.—*On Ferran's Anti-Cholera Inoculation.* By CHARLES CAMERON,
M.D. LL.D., M.P.

[Read before the Society, 4th November, 1885.]

FOR months past the press of every country throughout the civilised globe has been more taken up with Dr. Ferran's alleged discovery of a system of inoculation preventive of cholera than with anything else in the world of medical science. Assuming the discovery to be a real one, its importance to Great Britain can hardly be over-estimated. Not only are we exposed in common with other countries to the ravages of the dread disease, but we rule the great Indian Peninsula in which cholera is indigenous. In that dependency our troops and our administrators are constantly liable to attack, and our commerce, embracing every sea and land in its network, has to complain of continual interruption from the barrier of quarantine which other nations endeavour to set up against cholera whenever it manifests a tendency to emigrate from its native fastnesses. Under these circumstances one would have thought that our ministers would have considered it worth while to investigate and sift all evidence bearing on the nature and control of the disease. In the case of Dr. Ferran's alleged discovery, this could have been done at the expense of a few thousand pounds; but when I endeavoured to get our Government to move, before a single fact on the subject had come to the knowledge of the medical officers of the department by whose advice in sanitary matters our executive is guided, I found that those gentlemen, having on theoretical grounds decided that Ferran's system was absurd, refused to advise that it should even be enquired into.

That was four or five months ago, and since then we have had arguments *ad nauseam* showing that on theoretical grounds the whole thing was quackery and fraud. We have had assertions contradicted by evidence, and conclusions appealing to professional prejudice, and carried without a dissenting voice, but, save by myself, not the slightest attempt has been made to place before the public the strength of the case which so many are prepared—without enquiry—to refute. To me it seems that while theory based on facts is the indispensable handmaid of science, theory which ignores facts is a perjured and faithless jade. Well, what are the facts of the case, in ignorance of which so many condemnatory theories have been broached? If I state them in detail, and possibly at the expense of your patience, bear with me, for they are of vast importance, and to-night the details, on which everything depends, are for the first time made public in this country.

Let us commence with the case of Alcira, a town built on a small island in the River Jucar, in the province of Valencia. According to the official census, Alcira contains 16,000 inhabitants. Like many other provincial towns in Spain, it possesses a chartered Medical Faculty, or *Cuerpo Medico*, and it is on the faith of the formal declarations of that body, signed by its eleven members, and attested by the *Alcalde*, or mayor of the town, that I give my facts. Cholera broke out in Alcira in the beginning of April last, and during the month carried off some 20 or 30 victims. On the 1st of May, Dr. Ferran—who, as you all know, claims that he has discovered a preparation of cholera virus which, inoculated on man, protects him against cholera as the vaccine virus protects against smallpox—established himself at Alcira, and commenced work. Each person whom he inoculated had the particulars of his case registered, and received a certificate, on the back of which were printed the claims which Ferran made on behalf of his system. His inoculation would not, it was therein stated, confer absolute protection against cholera any more than vaccination confers absolute immunity against smallpox, but it would greatly diminish the risk of attack, and still more so the risk of a fatal result. The protection would wear out, and the operation should therefore be repeated from time to time. Finally, as in the case of persons exposed to smallpox contagion, a certain number of days must elapse before the vaccinator can assure his patients that the vaccination has secured them against an attack of the unmodified disease, so Ferran explicitly stated that under his system, in

similar circumstances five days were required to insure the immunity from cholera which he alleged it to confer, and that attacks within that period were outside the control of the operation.

By the 31st May, 7,043 persons had been inoculated and 4,117 of them had been inoculated a second time. During the month, while 121 uninoculated persons had been attacked, and 77 had died, only 23 inoculated persons had been attacked, of whom three had died, but all three had died within the 5th day after inoculation. These results, however, we will set aside, because while the 9,000 uninoculated had all been exposed to the cholera infection for a full month, the 7,000 inoculated had been exposed for a variety of shorter periods. The May figures, however, give us a definite point to start from. On the 31st of that month, as we have just seen, there were in Alcira 2,926 persons who had been inoculated once, and 4,117 who had been reinoculated, or 7,043 in all, leaving 8,957 uninoculated. On 30th June, there were 2,642 persons inoculated once, and 7,884 reinoculated, or 10,526 in all, leaving 5,474 uninoculated; and on July 31 there were 2,220 persons who had been inoculated once, and 8,830 reinoculated, or 11,050 in all, leaving 4,950 uninoculated. Taking these figures we find that the mean inoculated and uninoculated population of Alcira, in the months of June and July, 1885, and the distribution of attacks of and deaths from cholera among them was as follows:—

MEAN CONDITION OF ALCIRA POPULATION DURING
JUNE, 1885.

—	Mean No. of Persons.	No. of Attacks.	No. of Deaths.	Proportion of Attacks to Population.	Proportion of Deaths to Population.
Uninoculated, ...	7,216	182	91	1 to 39·6	1 to 79·3
noculated, including reinoculated, ...	8,784	48	10	1 to 183	1 to 878·4
JULY, 1885.					
Uninoculated, ...	5,212	101	58	1 to 51·6	1 to 89·8
Inoculated, including reinoculated, ...	10,788	28	11	1 to 385·3	1 to 980·7
JUNE AND JULY, 1885.					
Uninoculated, ...	6,461	283	149	1 to 22·8	1 to 43·3
Inoculated, including reinoculated, ...	9,539	76	21	1 to 125·5	1 to 454·2

But in order to avoid complications from cases of attack within five days from the date of inoculation, let us tabulate in the same manner the reinoculated cases, the cases which had fully complied with Ferran's recommendations, and about the fullest protection of which, according to his own statement, there could be no doubt.

**MEAN CONDITION OF ALCIRA POPULATION DURING
JUNE, 1885.**

—	Mean No. of Persons.	No. of Attacks.	No. of Deaths.	Proportion of Attacks to Population.	Proportion of Deaths to Population.
Uninoculated, ..	7,216	182	91	1 to 39·6	1 to 79·3
Reinoculated, ..	6,000	27	4	1 to 222·2	1 to 1,500

JULY, 1885.

Uninoculated, ..	5,212	101	58	1 to 51·6	1 to 89·8
Reinoculated, ..	8,357	19	5	1 to 439·8	1 to 1671·4

JUNE AND JULY, 1885.

Uninoculated, ..	6,461	283	149	1 to 22·8	1 to 43·3
Reinoculated, ..	9,943	46	9	1 to 150·9	1 to 771·4

These figures show that in a population of which the inoculated formed more than half, living in the same cholera-ravaged town during the same two months, the proportion of persons attacked among the uninoculated inhabitants was about $5\frac{1}{2}$ times greater than it was among all classes of the inoculated, including persons attacked within five days after inoculation, and the number of deaths $10\frac{1}{2}$ times greater, and that the number attacked among the uninoculated during the same time was $6\frac{1}{2}$ times greater than it was among the reinoculated, and the number of deaths nearly 18 times greater.

But it has been argued the official census of Alcira and every other Spanish town is utterly unreliable. The census, we are told, is enforced in order that a poll-tax may be levied by the Imperial Government, and the local authorities in consequence invariably return the populations as less than they are. As a matter of fact, therefore, it is argued, it would be safer to take the population of Alcira at 20,000 than at 16,000. One of the commissioners sent

by France to report—and whose report, when he came back, threw much discredit on Dr. Ferran's operations—was Dr. Brouardel, and he, by some marvellous process of intuition, puts down the real population of Alcira at 24,000. Ferran admits that in ordinary times the official figures are below the mark, but he contends that when a cholera epidemic attacks a town any one who can get away leaves it, and the number of inhabitants is rapidly reduced to that set forth in the census, and even below it. But let us waive that contention and take Dr. Brouardel's estimate, though it is several thousands higher than the highest figure on which any other objector has ventured. To do so in no way explains the mystery. It, of course, materially reduces the apparent immunity exhibited by the inoculated, but the uninoculated still continue to suffer much the more severely. It would waste too much time to go over all the tables before given on Dr. Brouardel's assumption as to total population, but adopting it in the crucial case of a comparison of the mean uninoculated and reinoculated populations during the two months of June and July the results would be as follows:—

MEAN CONDITION OF POPULATION OF ALCIRA DURING JUNE AND JULY, ASSUMING POPULATION TO BE 24,000.

—	Mean No. of Persons.	No. of Attacks.	No. of Deaths.	Proportion of Attacks to Population.	Proportion of Deaths to Population.
Uninoculated, ...	14,461	283	149	1 to 51	1 to 97
Reinoculated, ...	6,943	46	9	1 to 150	1 to 771

Even adopting, therefore, Dr. Brouardel's entirely unsupported basis of population, the number of attacks would still appear to be three times greater, and that of deaths about eight times greater among the uninoculated than among the reinoculated population.

But some cavillers urge the further objection that the inoculated portion of the Alcira population belong to a superior class—less exposed to the baneful influences of the epidemic than the uninoculated. I can hardly conceive how, in a small town like Alcira, 10,000 persons could be found much above the average of the poorest class, but the Cuerpo Medico has met the objection by declaring that 70 per cent. of the inoculated pertained to the class which contributed the bulk of victims of the epidemic. In order to test the value of the objection to the uttermost, let us

deduct the remaining 30 per cent., not from the inoculated, as we have done on the last occasion, but from the total inoculated population. Let us debit the remaining 70 per cent. with every attack and death occurring in an inoculated person whether occurring within five days limit or not. Let us add to the uninoculated population the 30 per cent. which we have deducted from the inoculated, and assume that not one single case of cholera occurred among its members. And, finally, let us add 50 per cent. to the official statement of the population so as to bring it up to Dr. Brouardel's extravagant estimate. Surely, if the thing is an imposition, this mode of treating the statistics vouched for by the Medical Faculty of Alcira should expose its utter hollowness. If it stands this test, assuredly there must be something in it. Let us try.

The mean number of inoculated and reinoculated persons in Alcira during June and July, 1885, was ...	9,539		
From which deduct 30 per cent., ...	2,861		
Balance, being the 70 per cent. certified to belong to the class that had furnished the mass of victims to the epidemic, ...	...	6,678	
The mean number of uninoculated persons in Alcira during June and July, 1885, taking the official census, was ...	6,461		
Add the 30 per cent. deducted from the inoculated,	2,861		
Add 8,000 to adjust population according to Dr. Brouardel's estimate, ...	8,000	17,322	
Total, . . .		24,000	

Dealing with these figures as we have dealt with the others, the following will be the result:—

HYPOTHETICAL ANALYSIS OF POPULATION OF ALCIRA IN JUNE AND JULY, 1885.

—	Mean No. of Persons.	No. of Attacks.	No. of Deaths.	Proportion of Attacks to Population.	Proportion of Deaths to Population.
Uninoculated, . . .	17,322	283	149	1 to 61	1 to 116
Inoculated, in- cluding reinoc- ulated, . . .	6,678	76	21	1 to 87	1 to 318

It therefore appears that the statistics of attacks and deaths, vouched for by the Cuerpo Medico of Alcira, have a reserve

vitality sufficient to enable them to defy even the extraordinary process of handicapping to which we have subjected them, a process which no single objector to them has even ventured to suggest, but which combines and accumulates all the objections which the most determined sceptics have been able to propose. Admitting all these objections, and piling them one on the other, it still appears that for 100 persons attacked among a given number of the uninoculated population only 70 were attacked in the same number of the inoculated, and that for 100 who died of cholera in a given number of the uninoculated population only 36 died in the same number of the inoculated. If we could cut down the mortality in cholera epidemics to 36 per cent. of its present amount the saving of life would be enormous. But here that result is shown to be achieved on an absurdly adverse assumption. Treating the Alcira statistics as the medical profession treat those of our own smallpox hospitals, the result of the Alcira experiment is to show in 7,000 fully-protected cases in one epidemic period of two months a saving of close on 17 cholera victims out of every 18.

But, though Alcira is the place in which the experiment was carried out on the largest scale, its statistics are far from being the only ones to be placed before you.

ALBERIQUE.

Alberique is a town, according to the official census, of 4,996 inhabitants, and the statistics in this case are vouched for by four medical men who practise there. Cholera broke out at Alberique on the 6th May, 1885, and up to the 17th of that month there were 15 cases of the disease and 6 deaths. From the 17th May to the 16th June 1,188 persons in the locality submitted themselves to Ferran's prophylactic inoculation. Among this number 548 poor workpeople were inoculated gratuitously, and 594 of the inoculations took place on June 12th, in presence of the Spanish Royal Commission, which had been appointed to inquire into the subject. Of the 1,188, 341 were reinoculated on the 16th June, on which date five days expired since the inoculation of the last batch. No further inoculations took place, and, as the report of the epidemic continues down to August 6th, we have a period of 51 days available for purposes of comparison. The population was, roundly speaking, 5,000, and of that, roundly speaking, 1,200 were inoculated. Among the uninoculated 3,800, during the 51

days, 84 persons were attacked, or 1 in every 45, and 33 died, or 1 in every 115. Among the inoculated there was not a single case of the disease.

BENIFAYO

is a town, according to the official census, of 3,615 inhabitants, and its statistics are vouched for by three medical men who practise there. According to these the first case of cholera appeared at Benifayo on 10th May, 1885. At that date no one in the town had been inoculated, but the inhabitants speedily sought inoculation at the neighbouring towns, and by the 21st June 408 had been inoculated and 225 reinoculated, leaving 3,207 uninoculated. In the eight days between the 21st and 28th of June inclusive 108 of the uninoculated population, or 1 in every 30, had been attacked, and 57, or 1 in every 56, had perished. During the same period not a single case had occurred among the inoculated population. If the disease continued to ravish the uninoculated inhabitants as it was doing, in another six weeks it would have decimated them. It was, therefore, determined to inoculate wholesale, and on June 28, 29, and 30, 2,315 persons were inoculated, thus bringing up the number of inoculated in the population to 2,723. Of the remainder, 160 had died, and the balance of non-inoculated, on the basis of the official census, was 732. As I have stated, Ferran, at the commencement of his operations, emphatically warned the public that his system of inoculation did not confer immunity till after the lapse of 5 days. During the five days from July 1 to 5, among the uninoculated 732 there were 18 cases of cholera and 17 deaths. Among the freshly-inoculated 2,000 odd there were 21 cases and 6 deaths, but of the latter in 4 cases premonitory diarrhoea had been registered at the time of the inoculation. From the 5th July to the 25th, 8 fresh cases and 9 deaths occurred among the 732 uninoculated. Among the 2,723 inoculated 1 solitary case was reported on 6th July, and it ended in recovery. The Benifayo certificate is dated 28th July, and for a week prior to that date there had been but 1 case. Had such a remarkable result followed on extensive vaccination in a smallpox epidemic there would be not the slightest hesitation on the part of the medical profession in accepting it as an example of the potency of that procedure in stamping out the disease.

CATARROJA

is another town in the province of Valencia, and, according to the most recent official return, its inhabitants number 5,521. On the 10th June last the first fatal case of cholera occurred. Nine cases occurred between that date and the 18th, and between the 18th and the 30th there were 219 cases and 88 deaths. A supply of Dr. Ferran's virus was obtained and 1,319 persons inoculated, the larger number on 1st and 2nd July. Five days would therefore bring us down to 7th July. The epidemic continued for another 18 days, and during that period 125 of the uninoculated 4,200 perished, or about 1 in every 33. After the five-day limit there were in all among the inoculated 1,320 only 13 cases, or less than 1 per cent., and 3 deaths, or one to every 440 persons.

CHESTE,

according to the census, contains 5,227 inhabitants. Cholera was officially declared to exist there on 16th June, but as on that day there were 6 cases and 2 deaths reported, it is probable that the true commencement of the epidemic was earlier. From 6th June to 30th June, 175 cases were reported, and 65 deaths. Ferran's assistance was invoked, and on the 30th June and 1st July, 3,136 persons were inoculated. Of that number 13 were attacked and 7 died within the first five days as against 29 attacks and 10 deaths among the uninoculated population of two-thirds of that number. This brings us down to 5th July. The certificate signed in the usual way by the medical men in Cheste is dated 10th August, and the last case of cholera had occurred on 6th August. During the month of the epidemic which had elapsed after 5th July, 47 attacks and 25 deaths had occurred among the uninoculated 2,000, while not a single case had occurred among the inoculated 3,000.

CHIVA,

according to the official census, contains 4,386 inhabitants. The local medical men who sign the certificate state that cholera showed itself on the 15th June. Between that date and the 29th June, 127 inhabitants had got themselves inoculated elsewhere, and the comparative immunity which they displayed induced a large number to avail themselves of a visit which Dr. Ferran made to Chiva on 29th June. On that and on the following day 1,181 were inoculated, which brought up the total number to 1,308,

against about 3,000 surviving uninoculated. The epidemic, though rapidly subsiding at the date of the report, still continued at 10th August. After the preliminary five days, therefore (during which 2 of the newly inoculated died), over five weeks remained for comparison, and the results were these. Among the 3,000 uninoculated there had been 138 attacks, or 1 to every 22 persons, and 53 deaths, or 1 to every 56 persons; among the 1,300 inoculated there had been 9 attacks, or 1 to every 145 persons, and 3 deaths, or 1 to every 436 persons. After the fifth day the inoculated population remained for close on four weeks absolutely free from cholera, and the fact that all 9 cases occurred subsequently to 29th July, the reporting medical men ascribe to the circumstance that an administrative order had been issued forbidding the reinoculations which Ferran considers indispensable to secure complete immunity.

The last town with the statistics of which I shall trouble you is that of

MASANASA,

a place, according to the census, of 2,596 inhabitants. Cholera invaded this town on the 5th May, and by the 17th there had been 8 cases and 5 deaths. On that day the local medical gentlemen who report commenced inoculation, and by 30th June, 418 persons had been inoculated. In this 92 attacks and 42 deaths had occurred, 3 only of the attacks and 2 of the deaths being among persons inoculated, and in each case these had occurred within the fifth day after the operation. It was therefore resolved to carry out inoculation on a wholesale scale, and on 29th and 30th June, 1,555 persons were inoculated, bringing up the total number of inoculated to 1,973. Within the first five days after the inoculation of the 1,555 persons, 37 attacks and 28 deaths occurred, of which 25 attacks and 13 deaths were among the newly inoculated. On the 6th July the population of Masanasa stood thus:—Inoculated, 1,960, uninoculated, 561, balance of 75 being dead. From the 6th July to the 6th August, both inclusive, the results were:—

In the 561 uninoculated,	35 attacks,	or 1 to every 16 persons.		
" " "	24 deaths,	"	22	"
" 1,960 inoculated,	11 attacks,	"	178	"
" " "	6 deaths,	"	326	"

The reporters wind up by stating that owing to the prohibition

issued by the Administration, they were unable to inoculate any other person, or to perform any of the reinoculations necessary, according to Dr. Ferran, to render the protection complete.

Before leaving this branch of the subject let us tabulate the results which I have just given :—

Period of Comparison.		Inoculated Population.	Deaths among Inoculated Population.	Uninoculated Population.	Deaths among Uninoculated Population.
ALBERIQUE	... June 16 to Aug. 6	1,188	0	3,808	33
BENIFAYO	... July 5 to July 27	2,717	0	715	9
CATARROJA	... July 6 to July 24	1,319	2	4,022	125
CHESTE	... July 5 to Aug. 6	3,136	0	2,091	25
CHIVA	... July 5 to Aug. 10	1,308	3	3,078	53
MASANASA	... July 6 to Aug. 6	1,960	6	561	24
		11,628	11	14,275	269

Deaths per 10,000 in Uninoculated Population, 188·44
 Deaths per 10,000 during the same period in Inoculated Population, 9·46

These facts are vouched for in a most formal manner before mayors and notaries by more than a score of different medical men. That they are inexplicable on any theory of understated populations I have shown by figures in the case of Alcira. No amount of tinkering with the figures of the census will explain away this difference. No amount of difference that can possibly be conceived in the surroundings of inoculated and uninoculated can account for it. Excluding Alcira, which we have already dealt with, we have six different populations, embracing, according to the only available information, 26,000 persons. Of these close on 12,000 were inoculated, and the difference is almost twenty to one in their favour. Arbitrarily doubling the number of uninoculated will not get rid of it. The advantage in favour of the inoculated will still be as 10 to 1. Assume in addition, in teeth of the teachings of common sense, that half the inoculated belonged to a superior class whose surroundings placed them beyond the grasp of the cholera demon, and still you have an advantage of 5 to 1 to explain. Do what you will, you cannot explain away the statistics I have placed before you. Would it not be wise

to look into them and see whether they are true or altogether false? If they are true a discovery has been made as great as that of Jenner. With so much evidence in support of them it is criminal in a country holding, as ours does, the breeding-ground of the cholera scourge in her rule to refuse to examine whether they be false or true.

There could be no difficulty in checking the statistics. A nominal list has been kept of all the persons inoculated, now numbering some 50,000, and there could be no particular difficulty in examining the case of any or of all the towns which I have named. I see that a correspondent of the *Times*, who, a few days ago, published a very fair *resume* of the statements on both sides of the question, mentions that in certain instances the list of Ferran's agents have been checked, and errors have been found. But the same correspondent states that the burial registers have, in many cases fallen into a state of confusion. In the panic and hurry, in the midst of which these wholesale inoculations were carried on, it is impossible that errors should not have occurred in the registers, but if, in addition to all the deductions which the most imaginative can devise—if we arbitrarily double the rate of the uninoculated population, if we strike off half the inoculated as belonging to a superior class, if, having thus reduced the advantage displayed by the inoculated population over the uninoculated from 20 to 1 to only 5 to 1—we, in addition assume that fifty per cent. of the names of inoculated attested by these various local practitioners and authorities ought to be struck off, as having been entered improperly, still the statistics I have given you would show that the remaining inoculated, after debiting them with the entire number of deaths, have suffered less by 250 per cent., than their uninoculated fellow-townsman and villagers. Let us admit it at once. If the figures which I have given are to be explained away, it must be proved that the 27 local medical men and the various mayors and officials, who, from personal knowledge, vouch for the facts I have given, are, without exception, the most reckless and barefaced swindlers that have ever figured in the history of mankind. In which case the Anti-Ferranists, with whom Spain swarms, and who are so well represented in France as well as Britian, must be unprecedented fools in having so long failed to bring such a transparent fraud home to its perpetrators.

The fact is, however, that very few men in this country know

anything about the science of inoculation, and a few of those who do having declared Ferran's system to be devoid of any scientific basis, the mass of those whose knowledge in that particular department of knowledge is limited have refused to take the trouble of examining facts, which they believed beforehand must be false. Let me endeavour to give the prejudiced a lead in another direction. Probably the greatest living authority on the subject of inoculation is M. Chauveau, of Lyons. Pasteur and Koch have of course made more startling discoveries in this particular branch of science than he, but no man living can compare with Chauveau in the patience, diligence, and perseverance which he has brought to bear in piecing together, working out, and elucidating the discoveries of other men. He it was who first demonstrated that contagia were not fluid or gaseous, but particulate. He it was who by a most ingenious experiment (described in a paper which some years ago I read before this Society) with mathematical clearness demonstrated the correctness of the theory on which Lister based his practice. He conducted an investigation into the relations of variola and cowpock which, in point of completeness and conclusiveness, stands unrivalled in the department with which it deals. Chauveau developed and elucidated Toussaint's discovery of the attenuation by heat of the contagion of splenic fever. Chauveau it was that taught us what we know as to the curious immunity enjoyed by certain breeds of animals against diseases which decimate other breeds of the same species. In his laboratory it was that Arloin Cornevin and Thomas made their discovery that the virus of Emphysematous Charbon introduced into the torrent of the blood circulation, conferred protection against that disease, while if planted in the solid tissues it was fatal. In short, as a master in all that concerns inoculation in every branch Chauveau stands second to none. Well, after having heard everything that could be urged against Ferran's system, after having listened to every argument that M. Brouardel and every other opponent could bring forward against it, in a paper read before the French Association for the advancement of Science at Grenoble, in the middle of August last, M. Chauveau unreservedly pronounces in favour of the scientific basis of the practice. He does not accept the theory which Ferran has adopted as to the mode in which it confers protection. He argues from analogy that the method of his inoculations might be improved, but on

two points he is perfectly clear—that on *a priori* scientific grounds the operation as practised, though unnecessarily severe, might be expected to yield the results which its author anticipated; and secondly, that the injection of the cholera organism into a portion of the human frame where its multiplication is strictly limited and its diffusion prevented, should not, according to the analogy of similar cases, give rise to any danger of inducing a serious form of cholera or promoting the spread of the disease. A few days after the publication of M. Chauveau's Paper, the joint report of MM. Paul Gibier and Von Ermengem as to the result of their experiments with Dr. Ferran's inoculation liquid—a report which showed that they had found the cholera organism at the end of three days in great numbers at the point at which inoculations with it were made, but could discover none either in the blood or the intestines—gave positive confirmation to the analogical assumptions on which Chauveau's reasoning was based. M. Chauveau was, of course, careful to state that his conclusion as to *a priori* probabilities would require the confirmation of carefully checked statistical facts. At that time the statistics which I have laid before this meeting had not been published. I have shown that, distort and twist them how one may, it is impossible to get rid of their significance.

If you followed the figures which I have laid before you, you would notice several further peculiarities to which I have not yet adverted. The wholesale inoculations which were practised did not lead to any exacerbation of the epidemic among the uninoculated. Thus at Cheste, for ten days before the inoculations commenced, the attacks amounted to close on 30 per 1,000 of the population. Between June 30 and July 3, 3,000 out of the 5,000 inhabitants were inoculated, and for the ten days commencing July 1, the number attacked among the uninoculated was but 25 per 1,000. This, and similar facts observed elsewhere, afford the most conclusive corroboration of the correctness of Chauveau's theory as to the absence of danger of spreading the disease through the operation, and furnish the most conclusive answer to those who affirm the existence of such a danger. The allegation that the operation may give rise to ordinary unmodified cholera in those who submit to it, is also emphatically refuted by the figures which I have quoted. Of course many of the inoculated were attacked within the five days immediately succeeding the operation, and several died; but the proportion was smaller than among the uninoculated. At Cheste,

for example, while the number of attacks among the uninoculated within that five days was about 15 per 1,000, that among the inoculated was under 5, and while the number of deaths among the uninoculated was 5 per 1,000, that among the inoculated was but 2.

Before concluding, I should like to say a word about some of the minor objections urged against the process. It is stated that it is conducted in a slipshod fashion, without proper antiseptic precautions—that the syringes employed are only disinfected by being washed out with hot water, that the culture fluid is exposed to the air, and so on. That of course is bad; but has it ever struck those who denounce such carelessness that our own vaccinations are conducted in an equally slipshod fashion? that the arm operated on is not sterilised, that the lancet used is at most dipped in hot water and wiped with a septic napkin, and that lymph preserved on points has been subjected to long exposure to the air. Has it ever occurred to them that in our hypodermic injections with morphia and other drugs there is no pretence at antiseptic precautions? It is said that in consequence of their neglect in the use of Ferran's liquid, instances have occurred of abscesses and blood poisoning resulting. Probably; but that is more a vice inherent in the system than is the inoculation of syphilis or erysipelas inherent in the scientific practice of vaccination. Such complications can easily be got rid of by the use of a little extra care, and, as a matter of fact, strongly antagonistic observers have admitted their existence rarely. Ferran alleges that in 150,000 separate inoculations made by him and his assistants, only some forty cases of phlegmonous inflammation have been noted. The first Royal Commission nominated by a hostile minister reported that the inoculations were absolutely harmless. The virulently hostile French commissioners report in the same sense. So does Dr. Romanelli, of Naples, who went to Spain to investigate the working of Ferran's system, while MM. Gibbier and Von Ermengem mention that their experiments on animals gave rise to no inflammatory symptoms. But a second Commission appointed by the Spanish Government has reported in an opposite sense, and everyone has heard of the terrible outbreak of cholera among the Little Sisters of the Poor inoculated at Valencia. True; but the second Commission was only appointed when the hostile minister who nominated the first found that its report entirely falsified his expectations, and its statement on this

point are in direct variance with those of a host of observers, most of them unfriendly to Ferran. As for the case of the Little Sisters of the Poor, there is absolutely nothing in it. It is on an exact footing with what occurred in all the cases of wholesale inoculation during the existence of the epidemic which I have quoted to-night. According to Señor Enrique Lopez, the Medical Officer of the establishment, what occurred was this. Between June 19 and July 1, 73 inmates of the institution took cholera, and 65 of them died. On July 1, 88 inmates, 13 of whom were registered as suffering from diarrhoea, were inoculated. During the first five days after the operation, 30 inmates were attacked and 16 died, 6 of the latter being among those noted as suffering from diarrhoea at the time of the operation. After the fifth day there was but one attack, and that was of a sister who had been absent on July 1, and had not been inoculated. I have not troubled you with the theory of the practice. I have confined myself to evidence as to facts, and to the scientific evidence of the greatest living authority on the subject of inoculation as to their *prima facie* probability. It seems to me that instead of scouting them we should welcome and test them; for, if substantiated, they for ever set at rest the question of the causation of cholera, they afford a means of combating a terrible epidemic which may any day force itself upon us, and—so far from discouraging—they throw a new light on those precautions as to cleanliness, disinfection, and insistence on a pure water supply, which must alway remain our bulwark of defence against the invasion of the fell disease.

II.—*South Africa and the Africanders.* By ARTHUR KAY.

[From the Geographical and Ethnological Section. Read before
the Society, 18th November, 1885.]

THE writer of this paper fears that there is little, which can be new to any of you, left to speak of in connection with South Africa. Before beginning, he would ask you, for half an hour or so, to put away from your minds any lurking political bias. No matter what his party is, the politician who will take the trouble to learn something about the people and country, and who can follow out a firm and unchanging, not a tyrannical yet fidgetty policy, is the right man to unwind the endless lengths of red tape in which Cape matters seem ever to be entangled. He would ask you to distinguish the Transvaal Boer from the ordinary Cape Boer, and to know that the cry "Africa for the Africanders," when raised by a Transvaaler, is about the same as "Home Rule for Ireland," when screamed by a dynamitard. Transvaalism is a power which may drag South Africa down in civilisation, it certainly will never push it forward.

There has been so much written and said about South Africa,—some of it eager praise of the Boers, and of their beautiful, religious, pastoral, peaceful, hospitable, simple life; some of it unreasoning hatred of them, and everything belonging to them,—that the writer feels almost afraid to give an opinion, lest you charge him with being at the beck of some personal prejudice.

The Cape is a conquered country. Both language and laws are mainly Dutch. The Dutch did not make a successful colony of it. We went in, and have been trying to make something of it—and them—for about ninety years. Failure is certainly not due to scarcity of broad acres, or of productive land. At this point a few statistics may help us, and the liberty will be taken of comparing an Anglo-Dutch with an Anglo-Saxon Colony. In round figures, the age of Cape Colony is two hundred years; that of Victoria can hardly be called fifty. The area of the former is 200,000 square miles, of the latter 87,000. The total trade of the Cape is £13,000,000, of which £3,000,000 is diamond, and

£2,000,000 wool, export; the total trade of Victoria is £34,000,000, of which £3,700,000 is bullion, and £5,900,000 wool, export. The banking facilities of the two states will not bear any comparison at all. Perhaps the most striking figures we can take are those of the Savings Banks' deposits, and land under cultivation. The Government Savings Bank deposits in the Cape show £21,000 ; in Victoria, £780,000. Other Savings Banks in the Cape, £334,000 ; in Victoria, £1,780,000 ; total in the Cape, £355,000 ; in Victoria, £2,560,000, the former being less than one-seventh of the latter. In the Cape there are about 600,000 acres under cultivation ; in Victoria 2,560,000. Surely push and industry must be the causes of this great difference ; for the population of the Cape is estimated at 320,000 white and 750,000 coloured—cheap labour—while that of Victoria is about 900,000, of whom 400,000 at least are in the three largest towns, and not employed in agricultural pursuits at all.

Some £15,000,000 have been expended on railways in the Cape, but, unfortunately, they are a monopoly in the hands of a Boer-biassed government, and rates in many cases are almost prohibitive ; at one time ox-wagons used to compete successfully with the government railway between Port Elizabeth and Cradock.

The writer would emphatically warn you against being carried away by the large figures of Cape trade, or by glowing newspaper accounts. Australian trade rests on the solid basis of agricultural industry ; Cape trade, to a great extent, on the precarious production of diamonds. The prosperity of the one country is assured by its dealing in necessities, that of the other is not assured by its lavish supply of the means of adornment for the fair sex—diamonds and feathers. To say that the Cape trade is seven times as great as it was in '54 is a true but misleading statement. It proves the lethargy of the Boer, and the existence of a diamond fever ; but not a sound development of the producing powers of the soil. The imports of bread stuffs have increased from $1\frac{1}{2}$ lbs. per head of the population in '69 (when diamonds were discovered), to 80 lbs. per head in '84. The value of British goods imported into South Africa during the past ten years has risen from £2,000,000 to £7,000,000. But that means little ; the production of diamonds—registered and stolen—and of ostrich feathers, is sufficient to account for it.

Australians understand the advantages of banking better than Boers. In one of the best agricultural centres of Cape Colony the

local bank manager said his deposits never exceeded £7,000, while the writer remembers a small village in South Australia where the deposits were £70,000. A wealthy Boer was deeply offended by a bank manager who offered him 5 % per annum for a box of gold he wanted to deposit for safe-keeping; this enlightened farmer's idea was, that it should be put in a strong room where it could be seen whenever he wished. Although he had not faith enough to deposit in the bank at 5 %, he afterwards collected all the notes he could, and tried to "corner" the local branch by demanding gold for them one Saturday morning. Another farmer near Potchefstroom died a few years ago, leaving a large sum in gold, which his sons could not count; so the eldest took the head of the table and dealt it out to them piece by piece.

An important point in forming an opinion of a people is their love, or otherwise, of games, and their production of men of fine physique. Victoria and New South Wales send out some of the finest cricketers in the world, and the champion sculler, while every village has its cricket club and football club. In the Cape there is no such physical excellence or widespread wholesome love of games, although the climate is as good.

Very much cannot be said for the political morality of either Colony. For while Victoria pays its members, and in Melbourne manhood suffrage permits a well-organised football club to carry a candidate, the Cape has no objection to a member who cannot pay his creditors.

Education has not been over-successful. A commission sat in '79, and after going into the evidence, reported, notwithstanding the great progress which education had made during recent years, the mass of the population was not yet alive to its advantages, and that in the Colony obstacles to its advancement existed, which are not found side by side in any other portion of the world. Amongst these obstacles are enumerated:—the conservative instincts of the people (please note that phrase), the preponderance of native population, and the existence of at least three different languages.

In 1869 the total trade of Cape Colony was about £4,000,000; in 1881—the climax of the diamond fever—it was £18,000,000. In 1869 the total shipping tonnage, entered and cleared, was 375,000; in 1881 it was 2,500,000. There was a reason for this. In 1869 diamonds were discovered. Five years ago in Kimberley nearly

everything had cost between 2d. and 3d. a lb. to transport there. It was a city of galvanised iron, with a white population living largely on tinned meat and fruits, and a dark population dwelling largely in huts made of old tin case-linings. The town stood on the edge of a large hole, out of which have been taken diamonds to the value of £30,000,000 sterling. In November, 1881, the average cost of transport to Kimberley was between £70,000 and £80,000 a week. Meat of any kind was ruinously dear. Coppers were unknown, the lowest coin in use was 6d. Drinkable water cost 1s. a pail, fuel from £5 to £15 a ton, according to the quantity in the market, a bottle of Bass, 4s. 6d. The smallest wage for the biggest, laziest rascal of a Kaffir was 30s. a week. Golconda is now a fable. Brazil is the name under which most Cape diamonds are sold. The fact is Brazil only yields about £60,000 worth a year. It is said that the price of diamonds has fallen from 60s. to 18s. a carat, and yet the export value *declared* of diamonds from 1st March, 1884, to the 31st August, 1885, is £3,913,000. In September, 1885, the average value per carat declared on production was 23s. 6 $\frac{3}{4}$ d.; now it is 18s. 0 $\frac{3}{4}$ d. A drop of 23 % in the most valuable export of the Cape represents the vanishing of dividends, and must affect the prosperity of Kimberley. There does not seem to be any fear of the diamond mines becoming exhausted for some years; the Central Company have a prospecting shaft 620 feet from the original surface, and 100 feet below the lowest level they are working in. From this the best of "blue," rich in diamonds, has been taken. Owing to the great depth of the mine and the steepness of its sides, immense falls of reef frequently occur, burying claims, which it takes weeks, and sometimes months, to clear. "Blue," the clay matrix in which the gem is found, varies in value according to the part of the mine which produces it, and may be worth from 10s. to 40s. a load.

The formation of the mines is very peculiar. They lie almost in a straight line. The nearest to the coast is Jagersfontein, not so well known as Kimberley, but justly noted for the purity of its stones. Some fifty miles further on is Koffyfontein, a very unsuccessful, but certainly a diamond, mine. About thirty miles more, and we reach the Du Toits Pan, Kimberley, Old de Beers, and Bultfontein mines, all near together; beyond those again are the river diggings on the Vaal, no doubt diamonds washed from yet undiscovered beds, and deposited by the river. One theory is that these mines are volcanic fissures, some say craters, filled with

the now solidified mud, which has been forced up from the interior of the earth, and left with its rich treasure of lovely crystals. Kimberley New Rush was a Kopje or Hillock, which the miners removed to a depth of 30 to 50 feet, finding large quantities of stones in a yellow, gravelly, sandy soil. Then they came on the "blue," and a panic ensued, for it was thought that the mine was exhausted. This "blue," however, was found to be even richer in stones than the yellow soil, and now, although worked to a depth of 300 to 500 feet, is as productive as ever. The boundary between diamondiferous and non-diamondiferous ground is very marked; one stroke of a pick being sufficient to take the miner from productive "blue" to barren reef. Kimberley mine, when the writer saw it, was a deep hole with an oval mouth, probably 1200 by 1100 feet. The "blue" was brought to the surface by large buckets working on wires; latterly large falls of reef have driven some of the companies to use shafts to raise it. It is then spread over large surfaces of ground called floors, in order that exposure to the air may soften it. Negroes next break it up, to make it small enough to be put into the washing machine. During this breaking up of the "blue" on the floors there is great risk of theft, as the clay frequently splits where there is a large diamond. Both on the floors and in the mines, the negro workers are watched by white over-seers, who earn large wages, but still are often suspected of theft. The curse of the diamond industry is theft, and, in spite of most stringent laws, the lowest estimate of loss thus caused to claim-holders, since the opening of the diamond fields, is between 10 and 12 millions sterling. Stealing has been more successful since private diggers ceased to exist, and companies began to work all the claims. The former looked after their own interests better. Stolen diamonds are generally large, hence the very heavy loss to companies.

Now Kimberley is depressed. Immense falls of reef have covered some of the best claims. The Transvaal War, and the Transvaal Convention, have destroyed the splendid market that was developing north of the Vaal. Money is scarce—very. Kimberley must look around for some additional source of income. Diamonds may become exhausted, or so cheap that the demand for them as ornaments will cease, but the trade that is possible with the interior of South Africa cannot be exhausted. Germans, we hear, are opening up Africa on the East; the Congo state has commenced to struggle on the West. But while Germany is showing both an enquiring

and an acquiring disposition with regard to Africa generally, Kimberley has the advantage of being the terminus of a railway system, and lies at the commencement of a trade route which can enable it to deal with all Africa below 10° South. A country rich in population, in minerals probably, and in ivory—which latter, the sooner exhausted the better, as it is a fruitful cause of idleness. Shoshong, Khame's capital, is now fairly accessible, thanks to Sir Charles Warren. This town taps the Lake Ngami district up to the Zambesi, Matabele country, and Damaraland. The country is healthy, and there are watering stations and a field telegraph along the road. Already Khame's people have begun to buy British textile goods and Sheffield ware, although six years ago they dressed in skins and hammered out their own spear-heads. Shoshong is the largest native town in South Africa, with an estimated population of 15,000. It is the capital of North Bechuanaland, and Khame claims sway over many subject tribes and peoples, stretching to the Tyobe River, one of the main tributaries of the Zambesi. This chief is courteous and kindly to Europeans, and his people are well governed. He has the strongest objection to the sale of alcohol in his dominions. Bechuanaland is not a desert, as some would make out. When the writer was in the country, much of it was well cultivated, and growing plenty of mealies. Natives held it. Since then, he has read of its being a howling wilderness and a barren waste, only fit for filibustering Boers. The wilderness did not howl much till the Goshenites went into it.

Diamonds saved the Cape from bankruptcy, and have put it on a fair way to prosperity. Merchants may develop an interior trade with the natives, and fringe the coast with a few busy ports, but it rests with the Africanders to make a great and prosperous country of South Africa. If they will not progress, and if railways cannot wake the Boer from his phlegmatic state of contentedness, the sinking of Cape Colony into a state of mediocrity will be coeval with the exhaustion of diamonds. A small amount of wool will be exported every year, and a small amount of merchandise imported; but those amounts will not increase much, nor will the funded wealth of the country grow. Cape Colony is as many leagues behind Victoria in everything appertaining to civilisation as it is years older.

Diamonds were not an unmixed blessing for South Africa,—nor were bullets—although the latter were money out of the pockets

of the British tax-payer. Diamonds and war fostered an unsound state of affairs. Boers left their farms to ride transport ; it was easy work. A waggon could carry 8,000 lbs., at prices ranging from 20s. to 40s. a hundred pounds for a twenty-five days' journey. This paid. So our tiller of the soil, and shearer of sheep, and grazier of cattle, left these arduous and slightly remunerative employments, and took his wagons and oxen to ride transport. There he could be seen on the road, asleep by day, travelling by night. Calling at the wayside winkels (small shops), and buying a box of sardines and some preserves, to eat in layers on his brown bread; not seldom he indulged in spirits therewith. When we hear that a man in Wepener, Orange Free State, for seven years lived mostly on tinned meat and biscuits, we do not wonder why in those days the Cape got through great quantities of Eno's Fruit Salt, Holloway's Pills, Seigel's Syrup, and other cure-alls, and that its consumption of patent medicines was—and is—prodigious. Soon the railway will be at Kimberley, and the great industry of transport-riding, already on the wane, will have received its greatest blow. This should do good to the country, for those who have been neglecting their original occupation will then return to their farms.

You cannot drive a Boer, nor must you allow him to drive you. We have never made a colony of South Africa in the proper sense of the word. It must be civilized, and not bullied. Ordinary minds generally condemn that which they cannot grasp, therefore many Boers condemn progress. In the palmy days of Boer bliss, ere the first diamond had glittered in Griqualand West, it was the custom for an undeclared lover, just after his lady had said good-night, to balance himself on one foot, and stretching out the other in front of her, to bar the way. This was a declaration of his wish to "opzit." Would that the Boer showed his desire to court civilization in so decided a manner. He has not yet solved to his own satisfaction the question whether knowledge of all things or ignorance of all things is preferable. Contentment is his bank, and with him experience, like the stern-lanterns of a vessel, simply lights the track that is left behind.

A Sour-veldt farmer near the coast grumbles because his cattle do not thrive, and his cows give little milk, unless he often lets them have a change of pasture ; nor can he rear his calves. The wife chimes in with the complaint that her failure with poultry has been as marked as his with quadrupeds. The geese are

weakly ; the hens, besides suffering from pip and other complaints common to poultry, lay eggs without shells. Evidently there is no lime in the district. After the greatest difficulty, this good couple are persuaded to try the effect of lime, and everything goes well with them. This is a type of farmer too numerous in Cape Colony ; hard-working, fairly honest,—though now and then one will, it is said, get his foot on the wool scale when selling produce to the storekeeper—but men who scout the idea that they have anything to learn about farming. These folks are slow to act, hate change, love land. There is little doubt that the weakness for holding more land than he can profitably cultivate, and the consequent burdens, help to keep the Boer back. In Boerdom, land-itch is like the measles, almost inevitable. Some even deem it a sin to make a dam, seeing that Providence did not think fit to give them water. A good agricultural college is wanted for the sons of these farmers, more than a Dutch Reformed Church school. It is said that the quality of Cape wool is deteriorating, and that fresh blood ought to be imported among the sheep. Fresh blood is more needed among the shepherds than the sheep. Farmers will not spend money in the storage of water, nor does the government of the country seem inclined to legislate for irrigation. It is true they are prepared to lend money for this specific purpose, but the requests for such productive advances have been very few. Many, if asked the cause of the present depression in the Cape, would say over-speculation in diamond stock, a fall in the price of diamonds, the low value of all classes of produce, lack of a war, and consequent lack of John Bull's money ; but they omit an important factor—lack of water is a great cause of the present wide-spread depression among farmers in South Africa. Why cannot the grand flow of the Orange River be utilized ? Instead of draining the country of water, it might be used to soak it. A Merv Turcoman is infinitely more productive than a Boer. If some of the Africanders could be placed in the Merv Oasis—wretched remnant of a former glory as it is—they should blush, for the industry of the Asiatic puts to shame the sluggishness of the Africander. Water is the most precious of Colonial advantages. It is the great factor of Colonial prosperity. Irrigation work would revolutionize the Cape. The very climate of the country would be improved, particularly if Australian blue gums were plentifully planted. Instead of farming being the risky occupation it now so often is, it would be a safe investment.

Farm servants would settle down with more than a hope of lasting employment, and their employers would be able to make something of their properties, from which at present they have too often to "trek" in despair. Continuous irrigation is cumulative in its effect. Soil is by degrees rendered more receptive. The water goes further every year. Boers have opposed the Scab Act, but even the most wilful will hardly be likely to fight against an Irrigation Act. In Australia, white labour has to be used, and costs about 7s. a day; in the Cape, native labour can be had, which, allowing for all its inefficiency, will be much cheaper than that. There are natives in numbers—too free. President Brand of the Orange Free State knows better how to govern them than we do. With their black muzzles up to the eyes in idleness and Boer brandy, they have little labour except for their teeth. They are not, however, a bad sort of fellows, if governed the right way. Handsome, supple, glossy, grinning, merry, musical, muscular men. The writer's experience of natives has been, that the further they live from so-called civilisation, the more sober, industrious, and agreeable they are. Now that guns, blankets, and brandy are taking the place of spears, skins, and Kaffir beer, the native is less interesting, because he is more commonplace.

Time will not permit of any account being given of the Bechuanas. A few minutes, however, may be spared to say something about a race of wild men, now very scarce in the Cape Colony, and who never have been, and never will be, civilized—the Bushmen, or as the Boers call them, Bosjesmen. The writer's ox-leader or "fore-louper" was a Bushman who had been trained on a Boer's farm, and a very strange type—half man, half monkey—he was. This curious race are supposed by some to be the aboriginal inhabitants of South Africa, and seem to have been very widely distributed. They bear a slight resemblance to the Hottentots, but none whatever to the Kaffirs. The Bushmen used to be found in their wild state in many parts of Cape Colony; but one of their great accomplishments being cattle-stealing, settlers, Kaffirs, and Hottentots have all done their best to exterminate and drive them out of the country. A Boer killed a Bushman as he would a snake. Now they are found through the Kalahari desert, or rather district—for it is no desert—up to near Lake Ngami, and even among the Ovampos, about 18° South, and 15° East. Dr. Schweinfurth has discovered the pigmy race of the Akka (beyond the Upper Nile Basin), Du Chaillu the Obongo (on

the Western Equatorial Coast), and De Compiègne the Okota (on a branch of the Ogowe River). These races bear a certain similarity to the Bushman, and seem to indicate the existence of an aboriginal race of dwarfs.

With the Australian aborigine, the Bushman is the very lowest type of humanity. He is rarely over five feet high, his colour, if his face has ever been near water, should be a sort of yellow, and his general appearance is not unlike the Mongolian type. They do not cultivate the land, and keep no cattle, but live by hunting—and occasionally by starving for a fortnight. Houses they have none. The shelter of a bush (hence their name), of a cave, or even of a hole scraped in the sand, forms their temporary home. Sometimes a few sticks driven in the ground to windward, with skins hung on them, make a more luxurious dwelling. They have no chief, bodily strength alone gives precedence. Each family, or small horde, roams about upon its own merits, and speaks its own dialect. If the strongest man takes a fancy for another man's wife, he takes the lady too, and keeps her until some stronger rival dispossesses him. Both men and women are hideously ugly. At the age of sixteen there is much grace of form, but from then it gradually vanishes, so that it is difficult to guess the age of a Bushman or Bushlady within twenty years. Such ambiguity regarding age might be appreciated in this country. The writer has seen a blue ape in Marico district with a countenance infinitely more prepossessing than that of his "fore-louper." He was very useful for sporting purposes. A keener eye for game it would be impossible to find—it could detect the tip of a duiker-bok's ear a couple of hundred yards off.

Before ostrich farms were invented many of the large feathers that came from South Africa were procured by Bushmen. An ostrich hunter's stock-in-trade consisted of an ostrich skin with full plumage, minus the legs, with a stick put through the neck, and his bow and poisoned arrows. The cunning little man, if he sees any ostriches in the distance, puts on the skin, makes his legs the right colour, and begins to play the ostrich, frequently dropping his borrowed head as though feeding. This plan generally results in his getting near enough to kill one or more of the birds, the feathers of which he puts into hollow reeds, so that they can be carried about without fear of damage, until sold to some trader. Large and dangerous game they generally destroy by trapping.

The weapon which saved the Cape Bushman from utter extermination was his poisoned arrow. Never fighting openly, but biding amid bushes or rocks, and making their raids by night, the Bushmen and their arrows were feared and hated by the other natives. If their bows had been as good as their arrows, they might have been the dominant darkies of South Africa; but fortunately they had no idea of making a good bow, and could scarcely hit a man at over twenty yards distance. There are three poisons, which are used in different districts—the juice of the *Euphorbia arborescens*, mixed with serpent's poison; the juice of the *Amaryllis toxicaria*, with the venom of a large black spider; and, worst of all, the contents of the poison grub *N'gwa* or *'Kaa*. Dr. Livingstone has described the effects of this poison:—"The sufferer cuts himself, calls for his mother's breast, as if he were returned in idea to his childhood, or flies from human habitations a raging maniac." Bushmen have been known to attack and kill the lion with arrows poisoned with this grub. They make no other weapons, having no idea of heating iron before hammering it out; if armed with an assegai, it has been bought from the Bechuanas, or taken from a fallen foe.

The bushman's diet consists of what he can get—ants, snakes, addled ostrich eggs, semi-putrid meat, or fresh stolen beef being all acceptable. When outspanned for two or three days in the same place, the "fore-louper" would eat and sleep the whole time; some tobacco, a little coffee, and unlimited fresh antelope, were paradise to him. Most of the natives of South Africa are gluttonous eaters of meat. The writer saw a few Bechuanas consume in a day one of his oxen that had died of bush sickness. Beyond one or two complaining that they had had bad dreams, they did not seem any the worse.

The most noteworthy trait of the Bushman is his artistic talent. Rocks in some of the hills of Cape Colony, and in the Drakensberg, are now and then to be seen bearing specimens of Bushman art—rude sketches of animals, men, women and children, also crosses, rings, and other signs in blue pigment. It is thought that these are many centuries old, and some speculative folk consider them to be the remains of hieroglyphic writing. In 1873 very old drawings of men and women, with antelopes' heads, were discovered in the Drakensberg; these have quite a mythological character. A few Bushmen may still be seen in various parts of Cape Colony as servants to Boers. The last remark the writer

saw about these people was that one had attempted to poison his master and mistress, and their family !

Your time has already been trespassed on, but perhaps we might devote a few minutes to the Transvaal. It would seem that Providence filtered the Africanders, and cast the residue into the Transvaal ; there were some rebellious *bacilli* amongst it, and, the surroundings being favourable, they have been in a ferment ever since they were left. The typical Transvaal Boer is ignorant, credulous, and fanatical. There is not a pauper in the country ; every Boer possesses land (in fact there is enough to support twenty times the present population), which only requires cultivation and water-storing ; or, if that cannot be done, large herds of cattle may run upon it. But, rather than work, the Boer, his wife, his sons, his daughters, simply *exist*. Ignorance and dirt are painless evils. Many of the Boers shoot game in summer, and dry it for winter provisions. Once, when lost in the High Veldt, two of us came upon a party of them. They had a waggon, ten oxen, a blanket each, a pound or two of coffee, a kettle, two tin cups, and one fork—and owned their thousands of acres. The ground was their couch—shaking the dew off their hair a morning toilet ; while breakfast, dinner, and tea consisted of bok-flesh, cooked in the ashes of a cow-dung fire, and washed down with a draught of coffee water.

The ordinary Transvaal Boer thinks progress his natural enemy. He said he wanted freedom. Freedom from what ? From progress, as brought about by good government. He “ tickles the land with a hoe, and it smiles with a harvest ;” that is all he requires. As for gold, silver, copper, lead, asbestos, coal, and iron, let them remain in the earth ; one cannot eat them ! He grows corn and tobacco ; eats, drinks, smokes, sleeps, dies—and is buried in his own back garden.

At the time of the annexation about 16 per cent. of the population were foreigners, the remainder immigrant Boers. But of the Government officials 15 per cent. only were Boers, and 85 per cent. “ uitlanders ” (British, Germans, Hollanders, and Swedes). Of the Volksraad 54 per cent. were Transvaal subjects. Before the annexation, debt weighed the country down ; credit, like a spring-bok, kept its distance. Officials lived on hope. The Treasury was a vaccuum. Three years had seen £10 spent on roads in a country as large as the United Kingdom. Postal communication owed its existence to charity, The Republic could not

raise £500 cash. Cetewayo was edging towards its borders. War expenses were ruinous, and an impossible railway scheme was also taxing the country. Surely reform was needed ; so thought the Boers then. But good government soon began to gall them. John Bull came into their country, and the unfortunate part of it is, *the Boers think* he went out as John Calf.

To refer briefly to the good done by the annexation, the good which was so soon undone. Cetewayo was overthrown. Sikikuni's power was crippled. Natives paid their taxes without a murmur, nor did they disturb the Boers on their farms. The Boer gibberish remained the official language. Taxation was decreased ; revenue, through proper collection, increased. Surplus stepped into the shoes of Deficit. Roads were made fit to travel upon. Letters had more than a probability of being delivered, and at cheaper rates than previously ; while prosperity showed its growth in the enhanced value of property. Even their Church was not disestablished. But our noble, pastoral, peaceful prodigy will none of this ; he must be as unrestrained as the rhinoceros, as unguided as the wild ass, he recks nothing of past history, of danger to his own and to neighbouring states. He asks for a telegraph line, and shows his appreciation by repeatedly destroying it. He begs for a railway, and then strenuously opposes the scheme, because it may tend to strengthen British supremacy. He offers up one prayer, and, when it is granted, says he meant something else. He wants everything, but since a dose of stable government must be swallowed to aid digestion, declares his intention of taking nothing. He christens opposition "Persecution," and it becomes sweet.

Such was the state of affairs before the rebellion broke out. It was not known before the outbreak, and probably is not generally known now, that the most powerful section of the Transvaal inhabitants consisted of the discontented scum of South African States generally. Men with bitter, brooding hearts dwell beyond the Vaal. The wilds of Central Africa behind, and authority in front, have made them desperate. Many of them were merely adventurous place-seekers, such as Joubert and Kruger. There is a curious sect in the Transvaal to which Paul Kruger belongs, the Doppers. In theory they are not unlike the Quakers. They were much persecuted at one time, but, when they got the upper hand, the property of their persecutors was confiscated to the State—that is, to the Doppers.

One *chef d'œuvre* cannot be passed over. The Transvaal has a Superintendent of Education (a clergyman), who was lately in London, and after his return gave a lecture. A few choice extracts, taken from a Cape paper, may be accepted:—"There were in London 260 miles of railways, and on the Great Eastern line the construction per mile cost £3,000,000 sterling. They would therefore see that the London railways cost about £780,000,000. From statistics, it appeared that in meat daily (by London) are consumed 400,000 slaughter oxen, 1,500,000 sheep, 130,000 calves, 250,000 pigs, 8,000,000 poultry, and fish equal to 100,000 oxen"! In faith, the Transvaal should be an enlightened and fruitful land, when the man who sows seed in the young mind of the country has such a gloriously fertile imagination.

One of the first Articles in the Constitution of the original Republic is characteristic:—"The people will not allow of any equality between coloured and white inhabitants, either in Church or State." Truly the Boers have been wise patriots, for, like some of our present prattling politicians, having nothing to lose, they sacrificed for the public good everything that was theirs. The rich were loyal to Her Majesty, the poor disloyal. They said they fought for freedom—the reason, if true, consecrates the act—but the reason was untrue. They were free to keep the law, now they are free to break it. Rebellion may be justifiable when it seeks for a higher rule, but not when it seeks to wander into mere lawlessness.

The writer has spent a good deal of time in the Transvaal and beyond it, and, although some of the Boers were most kind and hospitable, he must candidly confess to a preference for the natives.

It is natural that the idle poor should plunder those less poor than themselves. Hence the Boers walk into Dinizulu's territory, and attempt each to get a snug 10,000 acre farm. Their country once again is bankrupt. Some want to "trek" Zambezi-wards. Does it not seem strange that the patriotic Boers, who reconquered their country, talk of "trekking" to Zimbave? The main reason they give is that a railway is coming to the country some day.

You may think all this is pessimism or prejudice, but experience teaches that without Anglo-Saxon leaven, Boer dough will not rise. If there is a gold fever in the Transvaal, and a large influx of British or Germans, the country will go ahead.

To sum up, the stumbling-block of the Boer, from the time he landed in Cape Colony to now, has been land-greed. His wish

has ever been to accumulate thousands of barren acres, rather than to cultivate hundreds. South Africa is as good a country as New South Wales. It is fertile, and has a fair rainfall. The climate is splendid. It is six thousand miles nearer European markets than Australasia. There are many factors of success now existent or nascent—wool, mohair, diamonds, feathers, gold, interior trade,—two hundred thousand square miles of land, and only a thousand under cultivation!

Let us hope that a settled, honest Government, holding its sway from Cape Town to the Limpopo, improved means of transit, and the advantages which education can impart, will, within the next generation, radically improve, if not entirely alter, the present of this great country, making its future as bright as its skies, and its power as that of a Hercules aroused from slumber.

III.—*On the Verification of Traditions regarding the First Peopling of Certain Islands in the South Pacific.* By GEORGE A. TURNER, M.D., C.M., Secretary to the Geographical and Ethnological Section.

[From the Geographical and Ethnological Section. Read before the Society, 18th November, 1885.]

In investigating the subject of the origin of races, the question of the reliability of the traditions which are met with among many savage tribes is an interesting one. We are not aided much by our own experience as to the worth of such oral tradition, because now-a-days we know little of what happened further back than our own recollection and that of our parents, except what is preserved on the printed page of history. But the art of writing and of printing has not yet spread over the entire globe, and there are still to be met with peoples whose entire history is in the traditions of their ancestors. Throughout the South Pacific Groups, for example, where the art of writing has only been introduced in comparatively recent times, this system of handing down recollections of their origin and of other matters was well nigh universal, and I propose in this paper to bring under your notice one of the most remarkable instances where traditions of this kind have been verified.

Before proceeding to this, however, permit me to draw your attention to the view, which is now very generally accepted, that the different races in the South Seas, which go under the appellation of Malayo-Polynesians, are all offshoots of a family which populated some portion of South-Eastern Asia, probably about the Malay Peninsula, and the large Islands of Sumatra, Java, &c., and which at some remote period, almost certainly over 3,000 years ago, found their way eastwards all over the Pacific. It would appear from the *data* at our command that the Samoan Group of Islands, in the centre of the South Pacific, was one of the first to be inhabited, and that from this centre the Polynesian Race was gradually distributed over the Pacific—North, South, East, and West.

Another offshoot of this race is to be found in the Hovas of Madagascar; so that we have this Malay family spreading from

Madagascar and the Comoro Islands, in 43° East long., to Easter Island, in 109° West long., or over five-ninths of the circumference of the globe.

It has been objected to this view that the prevalence of easterly winds and westerly currents, almost all over the South Pacific, presents an almost insurmountable obstacle to the diffusion of this race from the West, but that this is not the case may very easily be proved.

It is true that the prevailing winds are easterly, but there are not infrequently contrary winds blowing for days together. It is true also that westerly currents are almost constant over the greater part of the South Pacific, especially in the belt extending from the Equator to about 10° S. That this South Equatorial current is a very strong one I have myself had more than one unpleasant proof. On one occasion in particular, in 1874, when going on shore for a few hours on the Island of Onoatoa, in the Gilbert Group, the wind fell light, the ship was drifted away, and I saw nothing of her for ten days.

But it must be remembered that, to counterbalance this strong South Equatorial current, there is an equally strong North Equatorial current setting in the opposite direction, and besides this, at occasional intervals, the South Equatorial current is completely reversed, and runs for weeks together just as strongly to the east as it usually does to the west. This was the case in June and July, 1877. In May and June, 1878, when cruizing in the Ellice Group, in the L.M.S. ship "John Williams," we came across acres of pumice stone floating on the surface, and found all the shores of the Northern Islands in the group covered knee-deep with it. We also passed several forest trees, which had been torn up by the roots, on which barnacles were only about half grown. Three months before this, violent earthquakes and volcanic eruptions had taken place in New Britain and the adjacent islands, and I have no doubt that the débris we met with at that time was from the said eruption, either having been carried eastwards by a temporary reversal of the prevailing current, or first north into the North Equatorial current, thence East for a long distance, and then round again into the Westerly South Equatorial current till we met with it drifting to the westward, about 2,000 miles due east of the scene of the eruption. It is not difficult to see, then, how easily parties of early navigators, either boldly pushing out in search of "fresh

fields and pastures new," or having been accidentally drifted away, have gradually been diffused all over these seas. We have numerous instances of this within our own knowledge. In the year 1862, for example, Elikana, a native of Manihiki, was, along with a few companions, drifted away from his own island in a canoe, and was nine weeks at sea before he fetched up on the island of Nukulaelae, in the Ellice Group, 1,200 miles from his starting point.

On the 16th May of last year (1884) the French barque "Buffon," bound for Tahiti from New Caledonia, foundered when about 270 miles S.S.W. of Rarotonga. The captain, one lady passenger, and the crew left the ship in three boats. Two of them succeeded in making Rarotonga; but the third, containing the mate and five seamen, made a long and intricate voyage of 45 days, passing many islands without seeing them, and at last, when nearly exhausted, having been eleven days entirely without food, was drifted up on the low coral atoll of Nikunau, about 2000 miles N.W. of where the ship foundered.

This Malayo-Polynesian race, then, is found scattered over almost all the tropical or sub-tropical islands of Polynesia, extending as far north as the Sandwich Islands, as far east as Easter Island, and as far south as New Zealand.

Some of the traditions of the first peopling of these islands are very vivid. The Maoris of New Zealand, for instance, tell how, after civil war, their forefathers migrated from Hawaiki, in the far north-east, in canoes, of which they give the names as well as the names of their builders and crews. This Hawaiki from which they came is plainly Savaii, the largest island of the Samoan Group, their language is essentially Samoan, and the list of their chiefs, which they give extending back from their present rulers to those who came in the canoes, numbers about 18 or 20 generations. In other words, a period of about 400 years—allowing twenty years to a generation—has probably elapsed since the first colonisation of New Zealand. It is not often, however, that traditions of this kind can be verified by direct evidence. In writing on this subject in his work on Anthropology, published in 1881, Dr. Tylor briefly mentions the instance which I wish to bring before you to-night.

The island of Nanumea or St. Augustine, lat. $5^{\circ} 39' S.$, long. $176^{\circ} 13' E.$, the most westerly of the Ellice Group, is one that long refused to have any intercourse with the outside world. When any vessel called at the island, a number of heathen

ceremonies were gone through. The new arrivals were taken to the place where were the representatives of their gods, and a number of prayers were offered up and incantations performed by the priests. These were to ward off the wrath of their gods on account of the arrival of strangers, and to prevent disease being brought to them. These ceremonies were repeated at the shrines of all the different gods, and took several hours to perform, and as all this time the strangers were kept in the burning sun, marched from place to place, and not allowed to hold any communication with the people till all was over, it is not to be wondered at that traders very seldom went near the place. I once asked the master of a trading vessel if he ever called at Nanumea. "Go to Nanumea," said he, "never; they won't buy anything from you if you go, and you can't even go ashore without having to be 'devilled.'" Attempts had been made also on repeated occasions to introduce Christianity to the island, but these had all failed.

About the beginning of 1873, I think it was, a Samoan native teacher, who was stationed on another island about 120 miles off, formed the idea that he would like to try and do something to Christianise Nanumea. With some difficulty he persuaded the captain of a New Zealand trading schooner to land him on the island. The vessel called at Nanumea, put the teacher ashore on the reef, and sailed away. The people were exceedingly angry—some wished to kill him, some to send him adrift in a small canoe, but the councils of a third party, after long disputation, prevailed, and he was allowed to live among them on condition that he would not interfere with their worshipping their own gods in their own way. He soon got quite at home with the people, and the result of his influence among them was such that, when I called at the island rather more than a year thereafter, I found that about two months before my visit the two kings of the island, eleven of the chief rulers, and about half the population had publicly renounced heathenism, destroying their idols and burying about two hundred skulls of their ancestors, which had been the objects of their worship. I landed, and was permitted to walk right up into the village—the first foreigner who had ever been allowed to do so without having to go through the process of being "devilled!" In passing, I may mention that whereas, when I first visited Nanumea in 1874, as just stated, no trader would go near the island, when I returned four years thereafter, five were resident on the island, and a thriving trade was being carried on

with New Zealand, Fiji, and Samoa. In talking to the chiefs, I asked them to give me some of the skulls above referred to. They at once sent and had *four* disinterred for me, two of which now have their last resting place among the late Dr. Allen Thomson's collection of skulls in the Hunterian Museum.

Moiono, the principal ruler of the island, who has, in fact, much greater authority than the two kings, in proof of their having given up heathenism, presented me with what had been to them the greatest object of their veneration and worship—the orator's staff of their ancestor Folasa, which he had brought with him from Samoa.

In Samoa, in former times—and the same very largely is the case still—the government was carried on by chiefs and heads of families, who formed the legislative body of the place. At their public meetings the kings and chiefs hardly ever spoke. Each had his representative orator, one of these heads of families just referred to, who spoke for him. When an orator stood up to address an assembly he laid over his shoulder his fly-flapper or badge of office, and held before him his orator's staff, leaning forward on it as he went on with his speech. These badges of office, the staff and fly-flapper, were handed down from one generation to another. It is a curious fact that representations of precisely similar staves and fly-flappers are to be found on some of the ancient Assyrian and Egyptian sculptures.

According to the tradition, then, which Moiono related to me, the inhabitants of Nanumea are descended from a party of Samoans headed by a man called Folasa, who were drifted away from their home and reached Nanumea, which was then uninhabited. Some time afterwards another drift party reached Nanumea from Tonga (Friendly Islands). In this second party there were some women, and the present population are the descendants of these two parties of castaways.

When he was drifted away, Folasa had with him his orator's staff, and for generations back this staff had been one of their principal objects of worship. The present rulers, they say, are the 31st generation from Folasa. Taking the same basis of calculation that we did in the case of the Maoris of New Zealand, we get a period of at least 600 years since the time when this drift party reached Nanumea.

Now, the proofs which I have to lay before you of the correctness of this interesting tradition are the following :—

First, the appearance, manners and customs, and the language

of the people, all plainly indicate their Samoan origin, while at the same time there are indications of the admixture of the characteristics of the Tongan race with that of the Samoan.

Second, the staff of Folasa itself, one half of which as you see is all decayed with age, and has a piece of wood tied to it to keep it from breaking in two. Now the wood from which this staff is made is the *toa* of many of the South Sea Islands, or the *swamp-oak* of Australia (*Casuarina Equisetifolia*). It is a hard wood of great durability, and on this account it was largely used on many of the Islands for the purpose of making clubs and other implements of war, and in Samoa orators' staves were often made of it. On account of its hardness many of the earlier voyagers to the South Seas called it iron-wood, though the real iron-wood is a different tree. Now, Nanumea is a low coral atoll, and, like all other islands of its class, there is almost no vegetation growing on it, except the cocoanut and the pandanus or screw-pine. Certainly no tree of the kind from which this staff was made grows nearer to it than Fiji or Samoa. The piece of wood tied to it to keep it together is quite different—it is a piece of cocoanut. That a piece of hard wood like this, which was constantly aired, and oiled, and handled, should be preserved for six or seven centuries, will, I think, be admitted as quite a probable thing.

Third, desirous of further testing the truth of the story, when I returned to Samoa I tried to find out from which district these people had come. I knew that the name Moiono, the name of the ruler of Nanumea who gave me the staff, was a noted orator's name in the village of Falefa, on the island of Upolu, and on further enquiry I found that Folasa was also a principal name connected with the same locality. Having to go up to that district very shortly after my return to Samoa, I took occasion at a public meeting, at which the chiefs and principal men of all the villages were present, to tell them about my visit to Nanumea, watching while I told it to see if the story would have any effect upon the old men of the village in question. I soon saw quite a stir among them, and after the meeting they told me that they had that day heard for the first time confirmation of an old tradition existing among them of a chief called Folasa having started with a number of followers in a canoe, upon some political errand, and never again having been heard of!

One more curious fact I may mention in closing. When showing this staff one day to an old noted Samoan orator, a man deeply

versed in all the traditions and *etiquette* of old Samoa, he took it from me, and, after looking at it admiringly for a few seconds, said, "What a tall man that Folasa must have been." I looked at him in astonishment and asked him what he meant. "Why," said he, "do you not know that it would be very ill-bred of any orator to speak with a staff longer than he is tall?" [The staff measures 6 ft. 10 in.] On further inquiry at other chiefs, all confirmed the statement, and I believe it to be correct, except perhaps in the case of orators from the political division of Samoa called Aana, who while speaking often stood with a *spear*, significant of the legacy of the spear which Aana received from the old legendary chief Pili.

One of the best authorities on the races of man, Oscar Peschel, says that "the lofty and volcanic islands of the South Sea, and the two continents of America, are the regions in which the human race has locally attained the highest stature," and of all the races of the South Seas none will excel if equal in stature and muscular development the natives of Nanumea. They are a veritable race of giants. I believe that at least nine out of every ten are over six feet in height. Need we wonder at this being the case when we consider that they are descended from such men as the Folasa of 600 years ago!

AUTHORITIES CONSULTED.

TYLOR—"Anthropology."

OSCAR PESCHEL—"The Races of Man and their Geographical Distribution."

TURNER—"Samoa, a Hundred Years ago, and long before."

IV.—*Telephone Exchanges and How they are Wrought.* By
Mr. D. SINCLAIR, of the National Telephone Company.

[Read before the Society, 2nd December, 1885.]

THE subject on which I am to have the pleasure of speaking to you to-night is—Telephone Exchanges and how they are wrought. I take it that, to members of this Society, the Telephone itself is too well known to require any explanation from me.

It was found, soon after the invention of the telephone, that, to have the full benefit of it in towns and cities, a central office in each must be established, into which the wire from the telephone in every subscriber's office must be brought, and so arranged there that an attending operator would have the power to join any two of the subscribers' wires together, enabling them to speak to each other. How this is done will now be my endeavour to explain to you.

The central office into which the wires are brought is usually termed the switch-room or exchange, more commonly the exchange. If we consider a very small exchange, made up of 40 or 50 subscribers' wires, the matter of joining any two of them together is very simple indeed, and any old design of almost any kind will do the work quite well; but when many hundreds of wires have to be dealt with, the manner of arranging and manipulating them so that comparatively no time is lost in connecting any two of them together is a matter which requires a considerable amount of skill and arrangement.

I have here one of the earliest forms of switch-boards used; and, as you see, it is made up of a number of parallel brass bars. To these bars the wires from the subscribers' offices, after passing through indicators, are connected, and terminate by the plugs connecting them all to the one intersecting bar, which is in connection with the earth, *i.e.*, joined by a wire to the nearest water-pipe. When a subscriber wishes to speak with any other subscriber he rings his bell, and the indicator in the exchange with his number drops, as you see this one drop when the bell is rung. Then the operator withdraws the plug thus, thereby

disconnecting his wire from the earth, and places it in connection with the next higher bar—the latter being connected with the operator's telephone. The operator, after learning the number wanted, withdraws the plug from the telephone bar, and puts the plug of the line wanted into the telephone bar, rings, then places the plugs of both lines in the same intersecting bar, and so connects the two, when the subscribers can ring and speak to each other until the plugs are returned to their original position, and the call is finished. Now we see that—without considering the telephone itself—even with the smallest exchange there is required a wire from the subscriber's office to the exchange with a battery—or more commonly a magneto bell—and an indicator in the exchange by which the operator can know when wanted. Such are the elements of an exchange, pure and simple, and all the other appliances (and there are many) are mere accessories to assist the operator to quickly and correctly join any two wires so together.

I have said that three things are necessary—a wire, a call-bell, and an indicator; and as they are indispensable in all exchange systems, I have here a sample of each.

The wire in general use is either iron, copper, or silicious bronze. Unless on long lines, such as those connecting Edinburgh and Glasgow, iron wire is not now much used, but for such purposes this is used, which is usually termed No. 8 Birmingham wire gauge (showing sample); its diameter is .165 of an inch, weighs 390 lbs. per mile, will bear a strain of 1150 lbs. before breaking, and has an electrical resistance of 12 ohms per mile.

Large quantities of this copper wire are now in use, it is No. 16; in some places No. 14 is used (showing another sample). The diameter is .065 of an inch, weighs 68 lbs. to the mile, and has an electrical resistance of 12 ohms per mile, or the same as the large iron wire.

Here is a wire made of silicious bronze, and it is very largely used on the Continent and in Scotland, but has not been much used in England as yet (showing third sample). In Glasgow alone we have erected over 200 miles of this wire since May of this year, and in Scotland within the last $3\frac{1}{2}$ years there has been about 1000 miles of this wire erected. It is No. 18, .049 of an inch in diameter, weighs 39 lbs. to the mile, and has an electrical resistance of 45 ohms per mile. Each of these wires is manufactured in different sizes, but these are the most common

in use, and as you see differ in size and appearance very much indeed. The iron wire is too heavy and not now used for overhouse lines. The copper wire, although better for speaking purposes than either of the other two, does not bear the tensile strain necessary for long spans; it therefore, when used, often breaks, and so is not suitable for overhouse work. The difficulty of getting fixtures makes long spans of from one to two hundred yards necessary, although 80 to 100 yards is the acknowledged best distance.

This bronze wire, weighing only 40 lbs. per mile, is in my opinion decidedly the best wire that I am acquainted with for aerial lines in towns and cities; and the difference between lines erected with this wire and the heavy iron wire is so great as to leave no comparison. I believe if all wires that have been erected in towns and cities these last 5 years had been of this kind, the chief cause for the many complaints against overhouse wires would never have existed, viz., unsightliness.

How hundreds of these wires can be erected without danger or any bad appearance can be seen by anyone taking the trouble to visit the roof of the Royal Exchange, Glasgow. There is our Central Exchange, with nearly 700 wires radiating from that point, and there are many places where heavy iron wires are used, where the general appearance is much more unsightly with $\frac{1}{5}$ the number of wires. As far as experience yet goes this bronze wire does not seem to deteriorate. It has been erected in Glasgow for three years of a smaller size than this, and weighing only 19 lbs. to the mile, and when examined lately was as good as when erected. Some ingredient from the air had entirely coated the wire examined, which, when removed, left it the same size and of much the same appearance as when erected.

Why not put all the wires underground? is the question constantly asked by many people, and most insisted upon by those who are least able to give any valuable opinion on the subject. There is no end to the suggestions, modes, and plans, for putting these wires underground. It appears to be such a universal question, that often gentlemen, whose only knowledge of the wires is seeing them from the street, or the top of a car, when plying their homeward way in the evening, are moved to ask—why not have all these wires put underground? And many a much-to-be-sympathised-with individual is afflicted with a mania for thinking over this subject, which results in letters

patent for sale, in which the whole world (electrical included) is informed that the inventor has found out how to put all the wires underground, which, if done as his patents direct, will obviate all difficulty with induction or overhearing, for all the wires are to be covered with something (perhaps paper) so that they cannot touch. Here is he, proud in believing that he has done something great, until he finds that no Company, or any one who knows of electrical matters, will have anything to do with his great invention.

The overhearing by induction from one wire to another is the only means by which speaking by telephone is possible, and this very inductive effect is the greatest difficulty the telephone engineer has to contend with. Many methods have been tried to overcome it, but time prevents me now from speaking of more than one. It has long been well known that when two wires are suspended near each other the speaking done on one can be heard on the other, although it is made certain that the wires do not touch at any point; and in practical telephone work it means that if two wires are run on the same poles for one mile, insulated at the supports with the best insulators known, the speaking on one can be heard on the other, and if extended to 5 or 6 miles, every word can be heard—the wires being throughout 12 inches apart. Overhearing always increases with the distance the wires run together, and decreases with the space between them.

The way in which this is overcome at present is to use two wires to do the work of one, making them into a metallic loop circuit, and twisting the loop in such a manner that the disturbing inductive effect from the other wire is brought to bear at the same moment on both sides of the loop, so that the tendency is for each half to have different effects upon the telephone, and as long as they are equal the telephone remains undisturbed.

The wires at present from Glasgow to Edinburgh, Greenock, Paisley, Dumbarton, Coatbridge, and Hamilton are erected and are wrought upon this principle with good results (as anyone who cares to try can demonstrate when the meeting is over).

With this rough diagram on the board I am able to show you how we work single subscribers' lines in Glasgow and Greenock in connection with the twisted loop between the two places. At each end of the loop there is put in circuit the secondary wire of an induction coil, and the single wires from the subscribers wishing to speak are put to earth through the primary wire in both cases.

So you see what takes place is, the subscribers' line in Glasgow passing through the coil of wire induces the current into the loop, and the current thus induced into the loop reinduces itself into the subscribers' line at Greenock and *vice versa*. These induction coils are called translators.

It is because of this inductive effect that the cost of putting the wires underground would be so great, as each subscriber would then require a loop of two wires to do the work that a single wire is doing at present, besides the immense cost and trouble that would be entailed by opening an underground connection with every building to which a wire went. The present grievance of seeing the wires in the air would become a much more substantial one, if our streets and pavements were being always torn up by workmen laying and repairing wires.

We now come to speak of the means of calling the attention of the Exchange when wanted, and what is in general use for this purpose is a magneto bell, of the type I have here. This is just a small magneto-electric-dynamo machine, driven by the hand. It has a Siemens' armature made up of a long thin silk-covered wire, with a high resistance of about 400 ohms; this armature, placed between the poles of two strong permanent steel magnets, and turned as you see by the hand quite easily, generates an intermittent current sufficient to ring a bell, or cause an indicator to drop at a great distance away on an ordinary wire. If tested through an artificial resistance it will ring the bell slightly of the other instrument through 14,000 ohms, which means that if this No. 16 copper was used it would ring that bell if connected at a point 1,200 miles away. In practice it would not ring the bell all that way, as there would be loss of the current by defective insulation, and other causes which would prevent it; but it would ring the bell nicely 200 or 300 miles away. The longest wire on which we use it is about 100 miles, and it works admirably.

The armature is very small, considering the effect produced; and this instrument, as made by the Western Electric Company of America, will work for years without requiring any attention. It is important to notice that the high resistance of the armature wire is not in circuit when the telephone is being used, the wire being shunted by this spring; but when the handle is turned round, the centrifugal force tends to throw this small cam out, on the same principle as the balls on a steam

governor. So as long as the armature is being turned round the shunt is open, and the current from the armature goes out to line; when at rest, the tension of the spring shunts off the wire out of circuit, thereby lessening the resistance and improving the line.

The switch on which the telephone is hung is so arranged that, when the telephone is taken off, the local battery is brought into circuit with the primary wire of the induction coil and the transmitter.

To have a correct idea of the telephone, it must always be borne in mind that the wire in connection with the diaphragm of the transmitter to which one speaks does not go out to line, but is entirely local. It starts from one pole of the battery, passes behind the diaphragm of the transmitter, through the primary of the induction coil, and back to the other pole of the battery; thus, the wire affected by the speaking at the diaphragm does not go out to line, but while passing through the induction coil it induces a current into the secondary of the coil, which is part of the line wire; so that we see it is the induced electrical impulses alone which travel out on the line wire, and in no sense whatever does any of the sound produced by the voice travel along the wire; it is simply the electrical impulses operating on the diaphragm of the telephone at the distant end that produces the same mechanical vibrations of the air as the voice on the diaphragm of the transmitter at the near end.

We come now to the third requirement—the indicator. It is one of the very oldest and best-known of electrical appliances—being the simplest form of an electro-magnet, which might justly be called the mainspring of all telegraphic and telephonic instruments. It is made up of two bobbins of silk-covered wire, having soft iron cores. A current of electricity, sent by the subscriber turning the handle of his instrument through these coils of wire, magnetises the cores, and they draw the armature towards them, overcoming the tension of the small spring and releasing the catch. The drop falls—showing the number of the subscriber ringing—and the operator replies as before described.

The ordinary resistance of an indicator is about 60 ohms; but I consider this is too high, and have reduced it on our long lines. The resistance of the indicators on the Glasgow and Edinburgh line is only 25 ohms. Here is another form of indicator, made up by the Western Electric Co. of America—being compact, and not likely

to get out of order. They have also a good working arrangement of the spring that joins up the night bell—used to, perhaps, awaken the operator, who, in the long, weary, small hours of the morning, has gone to that dreamland where even telephones are unknown.

Soon after the opening of the first Exchanges, and when they grew to have several hundreds of subscribers' wires, a difficulty was experienced in connecting any two of them together. You will readily understand this when I say an Exchange of 500 lines requires 10 tables, with 50 on each, and 20 operators. The manner we did it in our Central Exchange was to run five wires from No. 1 table to each of the other nine, five from No. 2 to each of the other eight, and so on until all the tables were connected together by having five wires to every table in the room from any one of the tables. So when a subscriber on No. 1 table wished a subscriber whose number was on No. 9, a small ticket was used by the operator at No. 1 table, who sent it to the operator at No. 9, with the number wanted marked upon it. Both wires were then connected to one of the five wires between the tables, the doing of which required two operators' attention, time, and labour to put through any one call. This, I may say, is the manner in which all the Exchanges in this country are wrought, with the exception of Liverpool and Glasgow. In July of this year we fitted up in Glasgow a new switch board system, known as the Multiple. The difference between this system and any of the others is very decided, because the single operator at any table can connect any of the wires she attends to, to any other subscriber's wire in the Exchange, and with the boards we now have will be able to do so until the number of subscribers lines reaches 2,000. It is done as follows:—There are four tables with 200 lines on each. The 200 lines on No. 1 table go to a jack with their respective numbers on each of the other three tables before returning to No. 1 table, and terminating there; and the 200 on each of the other tables do the same. Supposing a new line to be added to the Exchange, it will first come to No. 1 table, then to No. 2, then No. 3, and end at No. 4. Now, you see, the operator at any of the tables has power to reach it, so as to join any number to it, and at No. 4 table, where it ends, the operator, as all the wires pass through her table, can join this new one to any other in a moment, without the knowledge or assistance of anyone else in the Exchange. With this system it is necessary for the

operator to know whether or not any line wanted is already engaged, and this she finds out very simply. She takes the connecting cord and touches the jack of the line wanted; if engaged, a sharp click in her telephone tells her, and does not in any way interfere with the subscribers talking. If there is no click she inserts the plug and makes the connection. The facilities in this way afforded is at the cost of a very considerable amount of wire and connections in the Exchanges. The wire used for this in an Exchange of 800 lines is over 10 miles, and requires 8,000 soldered connections. The entire number of soldered connections in an Exchange of this size with the multiple system is about 20,000, and necessitates the use of about 45 miles of copper wire. I will now show on the blackboard how the click is heard in the operator's telephone without interfering with the subscribers speaking.

This multiple system is decidedly the best yet in operation, and it is coming largely into use in many places. I had the pleasure of showing and explaining its workings the other day to old friends—the native Director and Electrician of the Japanese Government, showing how soon an original idea started in America is carried round and round the world.

In large cities, to give subscribers the facility of being near an Exchange, it is the custom to open several and connect them by what is termed trunk wires to each other. In Glasgow there are 6. The principal one in the Royal Exchange Buildings, one in Hope Street, one in Sauchiehall Street at corner of Douglas Street, one in Byars' Road, Hillhead, one in Morrison Street, South Side, and one at Bridgeton Cross. To connect these we have now a trunk line Exchange placed at the Central Exchange. When a new one is opened the requisite number of trunk lines is run from it to the Central Trunk Exchange instead of what was done formerly, and is still done in many places. This obviates the anomaly of having more trunk than subscribers' wires to small outside Exchanges. Suppose an eighth Exchange, with 20 subscribers, to be opened in a city, and to work them four trunk lines to the seven existing Exchanges were necessary this would increase the required number of wires to 28. Now with our improved system we can do such work with 6 or 8 wires.

It was felt by telephonic companies that the expense of keeping ordinary Branch Exchanges always open was great, especially considering the small amount of work done at night and on Sun-

day, and likewise that for places a few miles distant from a Central Exchange where a few subscribers existed the expense of either running a line for each or keeping an Exchange open for them was too great. To overcome this, two years ago I patented an automatic switchboard to do the work of the operator in the Branch Exchange. I have here a small 6-line one, the first ever made, and I will show how it works.

Supposing there are six places in Renfrew that wish to join our Exchange system in Glasgow, I run one wire to Renfrew and attach it to this instrument; the instrument can of course be placed in any position and does not require an office. I then run a wire from the six different subscribers to the instrument—the operator in Glasgow has power to ring any one of them and speak without interfering with the others, and power to join any two of the six so that they can talk. Any of the six can ring the Glasgow Exchange when the single wire is not otherwise engaged. There is nothing required in the subscriber's office but the ordinary telephone and bell. When the wire to Glasgow is engaged any one going to his instrument can tell, as his bell will not ring. You see that by sending a current along the wire I can move the pointer to any of the six springs. These springs are the ends of the several branch wires, and the pointer itself is the end of the main line, and you see how the pointer is made to touch, one at a time, any of the six. Before the pointer moves on to No. 1 line, the current actuates the electro-magnet which disconnects all the six lines so that they cannot interfere, and when it arrives at the last step the sliding bar moves back and all six are again joined to earth. When any one of the six rings, the instrument is affected in the same way, viz., the current actuates the electro-magnet which cuts the lines of the other five, while the wire, being in connection with the drop of its indicator, is then in connection with the sliding bar and kept there, this bar being part of the main wire, and so Glasgow is rung. If any of the other five is wanted, the pointer is sent round to the number and they are then both in connection with the main line. The Glasgow operator, after hearing that they are speaking to each other, disconnects his main line and the two are free to talk. When they are finished the Glasgow operator sends as many currents as puts the pointer round to zero, and the instrument is again in its normal position. I consider that when the telephone patents expire, and consequently the outside lines rise to be the

most important part of telephonic communication, this instrument will fill a much more important place than it does at present.

The Telephone Companies have now power to open public offices, so that anyone in Glasgow, on payment of 3d., can speak with a Glasgow subscriber, and for 6d. to Greenock and the other outside towns. It is too expensive to keep an attendant at each of those places, and this check instrument (showing instrument) has been designed by another gentleman and myself to do the duty of an attendant. When pennies are put into the box, the operator at the Central Exchange has power to count them. Anyone wishing to use the instrument rings the exchange in the ordinary way. After giving the number wished, the operator tells him to put in the money, which, when done, he is put through. Each coin, in falling into the box, rings a bell in the exchange. When a sixpence is used it produces a certain sound in the operator's telephone, and does not ring the bell. A halfpenny or a three-penny-piece put in will not count, as neither of them produces any effect at the exchange.

If the party asking the connection is a subscriber, he inserts his ordinary check, turns it to the right, and a bell rings in the exchange; a subscriber to outside towns has a different check, which produces a different effect in the exchange.

This instrument is quite a new invention, being only completed last week, but preparations are being made to have a dozen of them at work in Glasgow within two or three weeks.

I am now done with what I have to say on Telephonic Exchanges and how they are wrought, and before finishing will give a few figures showing the amount of the work being done by them.

In Glasgow there are over 900 telephone exchange wires, doing on an average 5,600 messages per day, making for a year 1,752,800. The National Telephone Coy. have 10,000 exchange lines at work, making 300,000 connections per week, amounting to 15,600,000 a year. There are 30,000 telephones working in this country, sending daily 150,000 messages, and making for one year 46,950,000.

Telephones are much more used in America than they are in this country, and it is not because they are cheaper. In the large cities they are dearer than in this country. Taking our cities, we have a telephone for every 600; while, in America, they have a telephone for every 150. So it would seem that the

telephone is one of the requirements of our age; and I notice that, in the competitive race of countries, the number of telephones can be taken as a sure criterion as to which is pressing most to the front.

Finally, I firmly believe that electricity, having done so much to annihilate time and space, makes life very much more worth living. Certainly there is a class of people who imagine that modern life, under its conditions of steam and electricity, and bustle and hurry, does much to crush out the loftier sentiments; but it is to this class that George Eliot refers when she says that "poetry and romance are as plentiful in the world except for those phlegmatic natures, who, I suspect, would in any age have regarded them as a dull form of thinking. They exist very easily in the same room with the microscope, and even in railway carriages; what banishes them is the vacuum in gentlemen and lady passengers. How should all the apparatus of heaven and earth, from the farthest firmament to the tender bosom of the mother who nourished us, make poetry for a mind that has no movements of awe and tenderness, no sense of fellowship which thrills from the near to the distant and back again from the distant to the near?"

V.—*New Discovery of Rich Cannel Coal near Bathgate.*

By JOHN MAYER, F.C.S.

[Communicated to the Society, 16th December, 1885.]

As many members of the Society will remember, the Bathgate District became very famous some five-and-twenty or thirty years ago in consequence of the discovery of a nondescript cannel which was called Boghead coal, or Torbanehill mineral, and owing also to the celebrated "Coal or no Coal" trial which the working of it led to in the Court of Session. Some of the experts who were called upon to give evidence in that trial would persist in speaking of it as a bituminous shale, and denied its claim to be regarded as a true coal. Whatever it may have been in a mineralogical sense, it has since been practically all worked out where it was known to exist, both on the Boghead estate and on that of Torbanehill, which belonged to the late Mr. Honyman-Gillespie, and it was so rich for gas-yielding purposes that for a time it realised in the open market something like 90s. to 100s. per ton. Since the Boghead coal was worked out, the Bathgate District has, to a certain extent, declined in importance as a seat of mining industry, but many persons have from time to time expressed themselves confident that there was still a great store of mineral in it to reward future enterprise. This feeling found utterance in the saying, "Bathgate's no dune yet," and the discovery about to be spoken of seems to indicate the truth of that saying.

In the early part of this year a number of Glasgow gentlemen formed the Boghead Gas Coal Company, and secured a trial lease of between 500 and 600 acres of mineral property in the district, including the lands of Boghead, their aim being to work the deeply-situated minerals which they expected to find, one of which was a cannel coal quite as rich in illuminating hydrocarbons as the well-known Lesmahagow gas coal, if not even the same geologically as that celebrated coal. Messrs. Ronald Johnstone & Rankine, mining engineers of this city, were instructed to proceed and prove

the underlying gas or cannel coal by boring, and for that purpose they entered into a contract with Mr. John Vivian, C.E., Whitehaven, of the Cumberland Diamond-Boring and Tunnelling Company. The bore was put down on the Boghead estate, at a point between one and two miles from Bathgate Station, and within a short distance of a colliery where the same coal is actually being wrought. Work began in the month of May, and the expectation was that a bore to a depth of 240 fathoms or thereby would determine the presence or absence of the coal at that particular spot. A period of nine months or so was allowed for the completion of the work; but long before the lapse of that time the depth mentioned was reached, with the result, I regret to say, that the coal sought for was not found. For a time, therefore, the Boghead Gas Coal Company resolved to suspend operations, and in due course the boring rods and tubes were withdrawn from the bore. Doubtless the Company will by-and-by renew their efforts, although it may be necessary next time to proceed on another "tack."

This example of want of success on the Boghead lands did not deter another well-known colliery firm, who, as the owners of the Bathville Collieries, had already a large interest at stake in the district, in addition to that which they have elsewhere. I refer to Messrs. James & William Wood, of 40 St. Enoch Square, Glasgow, who are largely engaged in working gas coal in two or three counties. They secured a lease of about 600 acres on the Earl of Hopetoun's estate, which is immediately contiguous to the Boghead estate; and, in terms of a contract entered into with Mr. Vivian, they had the same set of diamond-boring machinery removed to a spot about three-quarters of a mile almost due north of the former bore. With it they commenced operations early in the month of October, which they prosecuted with much vigour night and day until the end of last week, when their perseverance was abundantly rewarded. Within a period of about ten weeks Mr. Vivian's representative was successful in running his diamond-armed boring tool through the Balbardie seam of cannel coal and its accompanying blackband ironstone and house coal, all of which occurred at a depth of rather less than 170 fathoms. The news of such an excellent "find" could not, on becoming known, fail to excite the liveliest interest among the people of the district, as well as the landowners and colliery-owners; indeed, within the past few days Messrs. Wood have been receiving hearty congratulations from very many persons, and especially from such as are interested in

the long-established fame of Scotch cannel for gas-making purposes both at home and abroad.

It may be worth while if I now give, for the benefit of Members of the Society, a few details as to the information obtained from an inspection which I have been permitted to make of the "journal" of this successful boring. I should first mention the fact that between the two bores already spoken of there is known to occur a great slip or downthrow of the mineral strata to the south. It is known as the "Sixty Fathom Slip," and such a slip or fault could not fail to cause a violent disarrangement of the minerals from their normal position. At the commencement of the boring the core of mineral brought out when the boring tool was withdrawn was 5 in. in diameter; in course of time the tool was changed so as to bring out a 4-in. core; and the last stages of the boring were characterised by the cutting and drawing of 3-in. cores. The "journal," as the entries are made from week to week, shows that in their general character the mineral strata passed through are similar to those found in various other mining districts, being a succession of shales, sandstones, black and grey fire-clays, thin seams of coal, here and there a shaly limestone, and so forth. But there are, in addition, well-marked mineral deposits at certain stages of the boring. One of these is the very characteristic "calmy limestone" of local geologists, its thickness in this instance being 4 ft. 6 in., while its depth is about 440 ft. from the surface. The same limestone occurred in the Balbardie sinking at a depth of rather over 300 ft., and its position in the Boghead boring was at a depth of about 694 ft. from the surface. Another limestone, 4 ft. in thickness, was found at a depth of about 600 ft. in Messrs. Wood's boring, and what seems to be exactly the same mineral seam occurred at a depth of 478 ft. in the Balbardie sinking. During the two weeks ending 21st and 28th November, a deposit of whinstone was passed through, whose total thickness was about 115 ft. It varied in colour from light and dark grey to dark green and brown. The boring tool first struck it at a depth of 689 ft., and the same sheet of whinstone occurs in the Balbardie sinking at a depth of 586 ft. In the course of last week another important "milestone," so to speak, was struck and passed through—namely, a dark grey shaly limestone, which local geologists and mining engineers will doubtless recognise as the representative of the very characteristic "Cowglen limestone," the thickness of which is 5 ft. 4 in., and its

depth about 928 ft. This is followed by 1 ft. 9 in. of black shale, and then there is a dark green whinstone fully 44 ft. thick, which is immediately followed by a grey shale 3 ft. 10 in. thick.

Next comes the important "find" for which the bore was put down. The Balbardie seam of cannel coal, 11 in. in thickness, was struck when the boring tool reached a depth of about 979 ft. Immediately adhering to its lower surface there is a seam of about 4 in. of very superior blackband ironstone, underneath which there is a 15-in. seam of fireclay, which is in its turn followed by a 15-in. seam of house coal, known as the "wee coal," which will compare favourably with the ell coal of the Hamilton District. The cannel coal is of a very superior quality, quite equal, it is said, to that of Lesmahagow, the yield of which is nearly 11,500 cubic feet of gas per ton, having an illuminating power of 34 standard candles, the sperm value being equal to 1,350 lb. per ton, while the ash in the coke is only about 5·5 per cent.

As I have already said, the ground leased by Messrs. Wood from the Earl of Hopetoun extends to about 600 acres, and there is good reason to believe that the valuable economic minerals found in the boring will extend to the westward all through Armadale. If that should, fortunately, prove to be the case, it will doubtless lead to an important future for the district. It is understood that Messrs. Wood will yet put down at least one additional trial bore before incurring the great expense of sinking an ordinary shaft to a depth of 170 fathoms to win the minerals mentioned. It will have been noticed that in the mass of dark green whinstone mentioned there is provided an excellent roof for the roadways and other levels, while in the case of a deposit of 6 or 7 ft. of grey sandstone under the "wee coal" there is an equally good "pavement." It should be mentioned, in conclusion, that at a depth of 25 fathoms below the level of the cannel coal there is the position of the "jewel coal," about 4 ft. in thickness, and that at 35 fathoms from the same level there is the Bathgate main coal. Let us hope that Messrs. Wood's enterprise and success will in due course lead to other equally successful enterprises in the same district.

VI.—*The Rainfall of the British Islands.* By ALEXANDER
BUCHAN, M.A., Secretary to the Scottish Meteorological
Society.

[Read before the Society, 16th December, 1885.]

CLIMATE may be defined as that peculiar state of the atmosphere in regard to heat, moisture, and rainfall which prevails in any particular place, together with its meteorological conditions generally, in so far as these influence animal and vegetable life. The diversified characters which climate displays may be referred chiefly to the combined operation of these four different causes, viz.:—distance from the equator, height above the sea, distance from the sea, and prevailing winds.

The greatest differences, however, in the local climate of places situated at no great distance from each other, arise from differences in the rainfall. The arid plains of the North-Western Provinces of India, as compared with the fertile higher slopes of the Himalayas contiguous to them, and the widely contrasted climates of the western and eastern slopes of Scandinavia respectively, may be cited as illustrations. In the British Islands there are, perhaps, no stronger contrasts of climate than those presented by Skye and the Laird of Moray. The mean temperatures of these two regions in no month of the year differ so much as two degrees, and for several of the months they are nearly identical. But the rainfall of Skye rises towards, and in many places exceeds, 100 inches annually; whereas, over the Laird of Moray, it is only about 26 inches. Now it is this difference in the rainfall, with the clear skies and strong sunshine that accompany it, which on the one hand renders the south shores of the Moray Firth one of the earliest and finest grain-producing districts of Scotland, and on the other, renders the island of Skye quite unsuitable for the remunerative cultivation of cereal crops. It is this aspect of the rainfall which gives it so paramount a place in the climatology of a country.

Of all meteorological data, the rainfall is the most difficult to represent cartographically; and there is no other way to arrive at even a tolerable approximation to the average rainfall of a district than by numerous rain-observing stations well distributed over its surface. Hence, in this inquiry, all available statistics of the rainfall for the period of years selected, have been used—the number of stations being 1080 in England and Wales, 547 in Scotland, and 213 in Ireland, in all 1840 stations. Notwithstanding this comparatively large number of rain-gauges, very extensive districts remain wholly, or all but wholly, unrepresented.

The period selected for the investigation is the 24 years ending 1883, and the principal sources from which the information has been obtained are the returns published by the Meteorological Societies of England and Scotland, and by Mr. Symons. For the method of discussing the results we refer to the recently published Part of the *Transactions of the Scottish Meteorological Society*, pp. 131-33. It may be here enough to say that the whole of the averages have been calculated for, or reduced to, the same term of 24 years, beginning with 1860 and ending with 1883.

The 1840 averages were then transferred to large maps of England, Scotland, and Ireland, and, from the results thus shown, the British Islands were shaded into six divisions, these shadings showing the districts where the mean annual rainfall—

- 1st.—Does not amount to 25 inches.
- 2nd.—Is from 25 to 30 inches.
- 3rd.— „ 30 „ 40 „
- 4th.— „ 40 „ 60 „
- 5th.— „ 60 „ 80 „
- 6th.—Above 80 inches.

On the map exhibited on the wall, these divisions are shown by three tints of blue and three of red—the blue showing a rainfall exceeding 40 inches annually, and the deepest tinted blue the regions of largest rainfall; and the red, a rainfall less than 40 inches, the lightest tint marking off those parts of England where the rainfall is least, or where it is less than 25 inches annually.

The regions of heaviest rainfall, marked off by 80 inches annually or upwards, are these four:—

1. The greater part of Skye, and a large portion of the mainland to the south-east, as far as Luss.

2. The greater part of the Lake District.
3. A longish strip, including the more mountainous portion of North Wales; and
4. The mountainous district of the south-east of Wales.

The rainfall is also heavy on Dartmoor and certain portions of the West of Ireland, but in these parts it does not appear quite to reach 80 inches.

The West Highlands present the most extensive region of heaviest rainfall in the British Islands. The mountain masses, along whose slopes and plateaux the rainfall is precipitated, offer a practically unbroken face of highlands directly in the course of the rain-bringing winds from the Atlantic. Particular attention is drawn to the circumstance that these mountain masses present many lochs and valleys directly in the course of these winds; up which, therefore, the winds are borne, and these cooling as they ascend pour down the deluges of rain which deeply trench the sides of the mountains in the lines of their water-courses.

This region of heaviest rainfall lies so far to the North of Ireland that the rainfall is not lessened by a previous partial drying of the Atlantic winds in their passage thither. To southward, however, it is quite different. Over the whole of the extensive tract of Great Britain, from Luss to the Lake District, there is not a single rain-gauge whose annual average reaches 80 inches, even although a number of rain-gauges have been planted in the higher districts, and in positions likely to furnish approximately the maximum rainfall of these districts. The diminished rainfall is no doubt due to the partial drying of the Atlantic winds in their passage across Ireland before they reach Southern Scotland.

St. George's Channel and the Irish sea open a free passage to the south-westerly winds, here diverted into a more southerly course, to the North of England, and to Wales, and accordingly where the mountain masses of the Lake Districts, and of North and South Wales, oppose their course, the rainfall over large portions of these high districts exceeds 80 inches.

The maximum falls in these four districts respectively are 185.96 inches at The Styne in the Lake District; 128.50 inches at Glencroe, Argyllshire; 116.90 inches at Beddgelert, North Wales; 96.18 inches at Ty-Draw, Treherbert, South Wales.

The largest region of 60 to 80 inches rainfall is in the West

Highlands, surrounding the region of still larger rainfall of 80 inches and upwards, and it extends from the Crinan Canal to beyond Loch Assynt, in Sutherland; then follow the hills to the north of Galloway; the north and east of Dumfriesshire; large portions of the Lake Districts; of North and South Wales; Dartmoor, in Devonshire; of West Galway; and the mountainous districts of Kerry.

An annual rainfall of 40 to 60 inches covers extensive tracts of the British Islands—a rainfall of at least 40 inches characterising the climates of about a fourth part of the surface of England, of about the half of Ireland, and considerably more than the half of Scotland—the latter, taken as a whole, being by far the rainiest of the three divisions of the United Kingdom. It is to be noted that nowhere along the East Coast of Great Britain, or for some considerable distance inland, does the average rainfall anywhere reach 40 inches. In the east of Ireland, on the contrary, the rainfall exceeds 40 inches in Wicklow, the south of Down, and the middle districts of Antrim.

Over the whole of the west of Great Britain the rainfall exceeds 40 inches annually, except from St. Bee's Head to Dumfries, and from Holyhead to Lancaster, these districts being largely protected from the rain-bringing winds by the Cumberland and the Welsh mountains respectively. It may also be stated that the rainfall of the Orkney and the Shetland Islands falls short of 40 inches, whereas in the Hebrides it exceeds that amount.

The shadings of blue on the map show in a striking manner the extension eastwards of the area of the 40 inches and upwards annual rainfall by the mountains of Sutherland, the Grampians, the Cheviots, the Pennine Range, and the hilly ground of the south-western counties of England.

On the other hand, the breakdown, at various intervals, of the mountainous or hill plateau, which may be regarded as extending along the west of Great Britain from Cape Wrath to the Land's End, has an equally striking influence on the distribution of the rainfall; and as regards man's material interests is even more important. Thus, the opening of the Bristol Channel, between Wales and the Cornish Peninsula, is the avenue through which is spread a more generous rainfall over a large portion of Central England than would otherwise have been the case. Through the breakdown of the plateau between the Pennine Range and North Wales, another large portion of England, extending from

Cheshire round by Derbyshire, and thence northward through Yorkshire, has its rainfall also very materially increased.

But the most remarkable of these breakdowns is the great lowering of the water-parting between the Firths of Forth and Clyde. Through the opening thus formed the south-westerly winds pass freely, and overspread Dumbartonshire, Stirlingshire, and the whole of western Perthshire, precipitating over these regions, a rainfall truly western as regards its copiousness and the direction of the winds with which it falls; and through the same breakdown there is extended, even eastward through Kinross-shire, a rainfall of fully 40 inches—an amount which occurs nowhere else over comparatively level plains, so far to the east of the water-parting between eastern and western districts.

The following are the rainfalls, in inches, at several points of the Glasgow district:—Millport, 41.30; Largs, 48.52; Morland, 60.70; Kelly Dam, 68.36; Greenock, 64.25; Dunoon, 77.30; Helensburgh, 52.92; Cameron House, 62.95; Glengyle, 95.41; Balquhidder, 76.70; Lochearnhead, 65.50; Ochtertyre, 44.17; and Pitlochry, 36.33.

Of the greatest importance is it to note the rainfall of Clydesdale lying to the south of this breakdown. The amounts are, in inches—29.98 at Bothwell Castle, 30.54 at Dalziel House, 31.66 at Auchinraith, and 32.37 at Murdostoun. Now, it is simply the southerly element of the rain-bringing winds which makes the rainfall of the Hamilton district of Clydesdale so essentially different, both as respects its amount and the times of its occurrence, from that of the Clyde below Glasgow. It may be noticed here, that when the rainfall of the west is in excess of the average, the rainfall of West Perthshire is also in excess; and on the other hand, when there is an excessive rainfall over the Hamilton district, it generally occurs that the rainfall of eastern districts is also in excess. The peculiarity of the rainfall of Glasgow consists in this, that it lies midway between these districts, which are so differently circumstanced.

The valleys of the counties of Kirkcudbright and Dumfries, with the intervening ridges lying athwart the course of the rain-bringing winds, show the inevitable result of a rainfall successively diminishing on advancing eastward. But on arriving in Eskdale, the most easterly of these valleys, we meet with a rainfall considerably in excess of that of any of the valleys to westward at the same elevations. The larger rainfall of Eskdale is due to its lying more in

the line of the Solway, and having immediately to eastward a high mountainous region, which the south-westerly winds must cross in their passage to eastward. The distribution of the rainfall over this hilly region, and over the valleys on each side of it, is instructive. Thus, at Kirkconnel Hall, near Ecclefechan, it is, in inches, 39.64; Canonbie, 49.72; Carlesgill, 58.00; Eskdalemuir, 63.30; Tudhope (on the ridge 1961 feet high), 76.43; and on the east of the watershed, at Teviothead, 54.86; Borthwickbrae, 44.36; Hawick, 33.55; and thence continues diminishing in descending the valley to 26.50 at Springwood Park, near Kelso. The reason why the rainfall of this region is thus distributed is, that the air on the windward side of the ridge being suddenly raised to a greater height in crossing the range, its temperature is continually reduced by mere expansion, and copious precipitation follows; whereas on the leeward side, as the air descends to lower levels, its pressure (or density) being increased and its temperature also thereby increased, it gradually becomes drier, and accordingly the rainfall diminishes rapidly with the descent of the aerial current to the low plains. A similar distribution of the rainfall is seen in crossing the Downs from Brighton to London, and over all other regions similarly situated.

It is the rapid increase of the temperature and drying of the air as the wind passes from high and wide plateaux into lower levels, which determines the areas of least rainfall of the British Islands. Accordingly, the smallest average annual rainfall, varying from about $22\frac{1}{2}$ to 25 inches, occurs in England, and overspreads a large portion of the south-eastern Counties, extending from the Humber to the estuary of the Thames, exclusive of the higher grounds of Lincoln and Norfolk, where the rainfall rises above 25 inches. In every other part of the British Islands the rainfall is above 25 inches. The influence of the higher grounds of Norfolk and Lincoln in swelling the rainfall, most probably by increased falls with easterly winds, is very striking. Similarly the rainfall of the Yorkshire Wolds is in excess of surrounding districts. Between the valley of the Thames and the Humber the rainfall nowhere exceeds 30 inches, except near the Chiltern Hills. It will be observed that the northern limit of the region marking off a rainfall under 25 inches annually is at the Humber, or near where Great Britain suddenly shrinks in breadth. It is, however, probable that the larger rainfall of the eastern part of Yorkshire, as compared with what

obtains further south, may also in part be occasioned by causes analogous to those which give Western Perthshire its large rainfall.

In Scotland no rain gauge gives an annual average under 25 inches. In three districts, however, the averages are only slightly in excess of 25 inches, and less than 27 inches, these districts being (1) Lower Tweeddale, from about Coldstream to Jedburgh; (2) the low-lying parts of East Lothian; and (3) the shores of the Moray Firth, from the mouth of the Spey round to Tain. It will be seen that these districts are not only well protected by extensive high lands from the rains of the south-westerly winds, but also from the, in many cases, torrential downpours of south-easterly winds. It is this double protection which gives the driest of its climates to these parts of Scotland.

In Ireland, on the contrary, only a small district round Dublin shows a rainfall less than 30 inches—this district being well protected by the Wicklow mountains from the rain-bringing winds; and as in that island there is no continuous mountain mass stretching north and south, there is no such great difference of rainfall and temperature shown between the eastern and western climates of Ireland as in the case of Scotland and England.

The narrowness of the strip round the east of Scotland, where the rainfall does not exceed 30 inches a year, is an interesting feature of which the rain maps constructed for individual months suggest the explanation. Of the rainfall of eastern districts, the larger proportion is due to easterly winds; and by much the larger portion of these falls usually takes place neither on the low-lying coasts nor at any great distance inland, but in the intermediate region, at heights from about 250 feet and upwards. The falls are also very heavy in low-lying valleys that open out so as to face these rain-bringing easterly winds. Of these rains the weather of October, 1880, afforded an excellent illustration. The rains of that month fell with strong north-easterly winds, and the fore-shores, looking to the north-east, of the Firth of Forth, the Moray Firth, and the Pentland Firth, had a monthly rainfall above the average, being in some places more than double the average; whereas over the rest of Scotland the rainfall was under the average, being over very extensive breadths from 70 to 98 per cent. less than the mean rainfall for October.

One of the most marked features of the climates of the South of England, to which many of our invalids are sent, is due to the influence of the Downs on the rainfall. Over the whole of the

somewhat broad region occupied by the Downs the rainfall exceeds 30 inches, rising near Petersfield to 40 inches. Along the south coast, and for a varying distance inland, as determined by the physical configuration, the average is less than 30 inches from Dover westward as far as the east shores of the Isle of Wight. On proceeding still further to westward, the annual rainfall slowly but steadily rises, till on rounding Prawle Point, in Devonshire, it begins to exceed 40 inches, and with this increase of the rainfall there is a still more striking increase of the temperature in the winter months.

The whole of the results arrived at in this inquiry, show conclusively that the key to the distribution of the rainfall of the British Islands is the direction of the rain-bringing winds in their relation to the physical configuration of the surface.

Looked at broadly, there are four very distinct causes of rain, viz.:—(1) The moist south-westerly winds; (2) rains, often very heavy rains, from the east, extending but a little way inland; (3) the annual fall of temperature from August to January; and (4), those peculiar influences that have their fullest development in the thunderstorms of summer over low-lying extensive plains. The rainfall of the British Islands has been examined with reference to its seasonal distribution in relation to the physical configuration of the surface. The mean rainfall of each place for the past 20 years has been calculated for the 12 months, these being reduced to 30 days each. The mean of those 12 months being taken, the mean monthly rainfall of the year was then ascertained; and with this latter mean, each monthly mean was compared, and its excess or defect entered in percentages, on 12 maps.

The moist south-westerly winds acquire their maximum annual predominance in December and January, and as these winds come loaded with the vapour of the Atlantic, the rainfall rises above its monthly mean over nearly the whole of Scotland. Two patches, however, are to a great extent exempt, these being the districts lying on the leeside of the greatest stretch of mountainous land, viz., to the north-east of the Grampians, and to the east of the Moffat and Lead Hills. Similarly in England during these months the rainfall is considerably below the average over the whole of the dry districts, extending from the Tweed southwards, and bounded on the west by the water-partings of the Mersey and the Severn, and on the south by the bed of the Thames, including the northern slopes of Kent.

During the time of the great annual fall of temperature from August to January, the greatest excess over the mean monthly rainfall occurs in September and October, when the fall of temperature is most rapid, westerly winds very prevalent, and heavy rains with easterly winds, chiefly the easterly winds of cyclones, of most frequent occurrence. In these months the rainfall reaches the annual maximum over large districts in the east of Scotland, and over all but the whole of England.

In the northern and the extreme western districts, nearly all thunderstorms occur during the winter months; whereas, few thunderstorms occur in eastern and central districts at this season, but nearly all occur in the summer months, a remark which applies with greatest force to the more extensive level, or comparatively level, portions of the country. Now, from the frequent occurrence of thunderstorms and thunder showers, the annual rainfall of these districts approaches to, and in not a few cases reaches, the annual maximum in the summer months. The local excess begins to show itself in June, is extended in July over the agricultural districts of Scotland and England which are best suited for the ripening of wheat and barley. In August there is shown a still further development and extension of the summer rains over these and adjoining districts. In this respect the climates of the important agricultural centres resemble the climates of Central Europe, where the rainfall rises to its maximum during the summer months.

To return again to the rainfall of Glasgow, the following are the annual amounts in inches in certain districts and along certain lines radiating in different directions from the city:—Glasgow, 40.20; Bushy Hill, 37.33; Bothwell Castle, 29.98; Dalziel House, 30.50; Lanark, 35.66; Wiston, 45.33—Queen's Park, 36.24; Newton Mearns, 52.63; Black Loch, 57.60—Paisley, 45.37; Castle Semple, 52.10; Blair, 53.63; Ardrossan, 41.03—Kilbarchan, 63.42; Kilmalcolm, 57.28; Greenock, 64.25; Overton, 71.45—and New Kilpatrick, 48.05; Dumbarton, 48.25; Cameron House, 62.95; Luss, 80.45; Firkin, 96.05; and Ardlui, 115.46. These figures show in a striking manner the extraordinary variations of climates there are in the immediate neighbourhood, or within easy reach, of Glasgow. Quite recently an inquiry was set on foot in Berlin, where numerous rain gauges were planted, with the view of arriving at some clear understanding as to the amount of observational information required in order to state

**MEAN ANNUAL RAINFALL OF THE BRITISH ISLES,
FOR THE 24 YEARS FROM 1860 TO 1883.**

(Published with the kind permission of the Scottish Meteorological Society.)





definitely what the actual rainfall of a district is. Might I suggest to the Mathematical and Physical Section of the Philosophical Society that a similar investigation be taken in hand, and forty or more rain-gauges be added to those already in use. In a few years not only would the Society be able to answer the question proposed by the Berlin meteorologists, but in answering it state with satisfactory precision the character and limits of the various local climates which differ so widely from each other in the neighbourhood of Glasgow.

[See Map printed with permission of the Scottish Meteorological Society.]

VII.—*The Present Position of the Museum and Art Galleries of Glasgow.* By Bailie JAMES HUNTER DICKSON, Chairman of Museum and Galleries Committee, and JAMES PATON, F.L.S., Superintendent of Museum and Galleries.

[Read before the Society, 3rd February, 1886.]

As a large proportion of the people who are interested in the welfare and development of the Art Galleries and Museum of Glasgow are only imperfectly acquainted with the history of these institutions, and with the causes which have operated towards bringing them to the position they now occupy, it may not be unprofitable to give a brief outline of their history and vicissitudes. From the standpoint of past experience, and the present conditions and limitations arising therefrom, it will be more easy to determine what is necessary to secure the development of Museum institutions adequate for the necessities and dignity of the great commercial and industrial city of Glasgow.

The beginning of the Museum of Glasgow—we use the term Museum in the comprehensive sense, as covering both Art Galleries and Museum—was made in 1856 by the acquisition by the Town Council of the collection of pictures which had been formed by Mr. Archibald M'Lellan. That collection it had been Mr. M'Lellan's purpose to devote to the public, and his intentions were so expressed in a Deed of Bequest; but, as the testator's affairs were involved at the time of his death, it was found impossible to carry out the provisions of his will. Under the circumstances, the Town Council, after considerable negotiation, purchased the M'Lellan Collection of Pictures for £15,000, and the heritable property in which Mr. M'Lellan had erected a suite of galleries for £29,500—in all £44,500. The heritable property included the three halls in which the M'Lellan Collection was arranged, and the block of shops and dwelling-houses on the north side of Sauchiehall Street, between Rose Street and Dalhousie Street. The purchase of the heritable property may be looked on in the light of a commercial investment, and thus we have to regard only

the £15,000 as being the sum actually expended on the acquisition of the nucleus of the Art Gallery and Museum of Glasgow. About the year 1867 private tenants—excepting the occupiers of shops—were displaced from the property, and a certain amount of reconstruction was undertaken to adapt the upper floors to public purposes. The whole of the eastern section over the shops was appropriated to the Glasgow School of Art. In the western section the upper floor was transformed into galleries and exhibition halls; and on the first floor was found accommodation for the libraries and committee rooms of the Philosophical Society and the Institution of Engineers and Shipbuilders, with a lecture room *en suite*. These alterations were undertaken principally on the recommendation of Mr. C. Heath Wilson, and while the changes still left a large proportion of the property rent-yielding subjects they added greatly to the accommodation of the galleries. The whole cost of the structural alterations was less than £4,000, so that the capital expenditure on both pictures and buildings remained considerably less than £50,000.

It must be borne in mind that the original Galleries, and their extensions also, were equally regarded by the Council as rent-producers, and from the first the halls were let to private applicants for a great variety of purposes, such as public lectures, balls, concerts, bazaars, and other similar entertainments. These applications of a gallery of art were manifestly inconsistent with its proper use as a public institution; but the whole matter was looked at in the early days merely as a question of investment, and in that sense it was not a success. From 1862 onwards the Glasgow Institute of Fine Arts was a tenant for its yearly exhibitions, and for many years these exhibitions were the only real artistic use to which the Galleries were devoted.

At the time the extension of the Galleries was undertaken a spasmodic effort was made to place the collections and the public relation to them on an improved footing. The new Galleries were inaugurated with an exhibition of local historical portraits, and a collection of extreme importance for the illustration of the history of Glasgow and the West of Scotland was brought together, of which a most valuable catalogue was prepared by Mr. Heath Wilson. The exhibition, however, was a pecuniary failure, and on Mr. Wilson resigning the Curatorship of the Galleries—an office he held for a short period only—a decreasing interest was manifested in the institution, and it gradually fell into the most

regrettable and detrimental condition of public neglect. The landlord attitude of the Town Council came indeed to overshadow and crush out all other relations and responsibilities, and the M'Lellan pictures, and other art property which had been added by gift and bequest, were regarded as mere ornamental adjuncts to balls, concerts, bazaars, and dinners for which the halls were hired. It can scarcely be wondered that, under such a course of treatment, the pictures fell into disrepute, people began to doubt whether they were even ornamental, and their presence was regarded as a hindrance to the free use of the halls for miscellaneous purposes.

Notwithstanding these discouraging conditions, important bequests and donations were made to the art collections, the most considerable of which were, 1st, the gift, added to by subsequent bequest, of a large number of pictures by Mr. W. Euing; and 2nd, the bequest by Mrs. Graham-Gilbert of Yorkhill of the gallery of old masters formed by her husband, John Graham-Gilbert, R.S.A., with a large number of that artist's own works. Next to the original M'Lellan pictures, the Graham-Gilbert collection forms by far the most extensive and important section of the Galleries as they now are constituted.

It was immediately after the receipt of the Graham-Gilbert bequest that a serious effort was again made to rehabilitate the galleries, to bring them back to their original and proper function, and to re-establish the tarnished reputation of the art collections. That has proved a work of great difficulty; and after eight years of labour, complete success is yet far from being attained. The M'Lellan collection became public property in the face of a large amount of active hostility, and twenty years of greater or less neglect deepened public prejudice into contempt. Twenty years of the exposure and treatment to which the pictures were subjected—to gas, smoke, and dust; to alternate exposure on walls, and storing in closets—worked incalculable havoc in the condition of many of the works. The condition of the collections, therefore, first engaged the attention of the Parks Trustees, who invited the late Sir Daniel Macnee, Sir William Fettes Douglas, his worthy successor in the presidential chair of the Royal Scottish Academy, and Mr. Robert Greenlees, to inspect and report on the state of the pictures. These gentlemen made a careful and minute examination of the entire collection, and they recommended the exclusion of a considerable number of works from the permanent list; but upon the whole they were able to report in satisfactory terms of

a large portion of the works. Taking into account the loss and injury suffered by the M'Lellan collection especially, by a long course of neglect and abuse, the condition which his works were in the end found was ample testimony to the skill with which that venerable amateur selected his gallery, and to the marvellous appreciation he possessed for the great and enduring qualities of the older schools of art. On the basis of the recommendation of these three advisers of the Parks Trust, the preparation of a catalogue of the pictures to be retained in the permanent collection was proceeded with. No records or other materials for such a catalogue existed in the Institution, and as in most cases it was impossible to trace the history of the separate works, a feature valuable at once for the catalogue and for the reputation of the collection was wanting. When such a catalogue as it was possible to compile was in type, it was deemed advisable to obtain a written report from some critic of extensive knowledge and recognised authority, and whose opinion would command general attention and respect. Mr. J. C. Robinson, F.S.A., H.M. Surveyor of Pictures, accordingly was invited to examine and report on the artistic position of the collection; and the statements embodied in that gentleman's report have been not only of the most beneficial consequence in changing the current of local opinion as to the value of the collection, but also in drawing the attention of the art authorities of all lands to the importance of the Glasgow Gallery, which is now on a fair way of having conceded to it its proper place among the great public collections.

In the year 1880 the Institute of the Fine Arts, the Philosophical Society, and the Institution of Shipbuilders and Engineers ceased to be tenants in the Galleries property, and thereby the Parks Trustees came to have unfettered control of their halls, and were in a position to devise schemes for their utilisation for public exhibitional purposes entirely under their own supervision. It was perceived that special efforts were necessary to extend the usefulness of the institution, to advertise its existence to the great mass of the population, and to induce in the public the habit of visiting the institution, and of regarding it as one of the attractions of the city. Towards these ends a series of temporary exhibitions was resolved on, of such a nature that, whilst they would interfere little with the picture collections, they should bring together, for a limited time, large numbers of important treasures of art of the highest value to the art student and work-

man, and at the same time attractive to all persons of cultivated taste. These exhibitions fulfilled their educational purpose in a most satisfactory manner, although they were carried out under several unfavourable conditions. The lighting of the halls in which they were held was more designed for illuminating wall than floor spaces. At no time is the amount of light sufficient, but in the dark days of winter the deficiency is painfully obvious. Thus the objects obtained on loan were badly seen, and there was an entire want of that bright cheerful effect, which has so important a bearing on the popularity and success of an exhibition.

The market value of the collections obtained on loan by the Parks Trust for these exhibitions was very great; and in a large number of cases such was the historical or artistic interest of individual objects that no price could compensate for their loss or injury. It was well known all along that the position of the Galleries exposed them to considerable risk of fire, and although within the halls themselves every precaution was observed, it was not possible to control the action of tenants of shops, whose very trade was of a hazardous description. Fire having repeatedly broken out—as many as four times in four years, the building was placed in serious jeopardy—the Committee were ultimately driven to the conclusion that they would not be justified in continuing the grave and onerous responsibility they incurred in accepting loans of such great value and importance as made up these loan exhibitions. They therefore came to a resolution not to solicit valuable loan collections while the dangerous condition of the Galleries continued. The exposure to the chance of conflagration has not yet been lessened, and although the responsibility of the Parks Trust to private owners is decreased, the great Glasgow art collections—in which are included some of the works which rank among the treasures of the world—and which embraces donations and bequests from among many of the most esteemed citizens of recent times, are still daily exposed to the tender mercies of careless and irresponsible outsiders who deal in the most inflammable commodities.

We may now briefly sketch the career of the Kelvingrove Museum. In the course of the year 1869 the Town Council resolved to convert the mansion-house of Kelvingrove into a temporary Museum, and, accordingly, after making such structural alterations as were required, a beginning was made under the name of the City Industrial Museum early in 1870. Thus the

site was fixed, not from any regard to its fitness, but simply because of the accommodation the old house offered. That accommodation was indeed not much, and in 1874 the Museum Committee, with the sanction of the Council, appealed to the public for subscriptions towards the extension of the Museum, and a sum of £7,500 was thereby obtained, to which the Council added £700. These amounts were spent on the wing attached to Kelvingrove House, and we may take it that something under £10,000 has been expended on the buildings in Kelvingrove Park as they stand.

The extension of the Museum was opened in 1876 with an Exhibition of local industries organised in connection with the meeting of the British Association in Glasgow, and almost from the very first the space it afforded was so fully occupied that the insufficiency of the accommodation was immediately obvious. The temporary and makeshift nature of the provision made for the Museum was at once perceived and acknowledged by the Council, and from time to time during the last seven years various schemes have been under their consideration for dealing fully and finally with that question, but no decision has yet been arrived at. Under the provisions of the Glasgow Public Parks Act, 1878, full powers were obtained by the Lord Provost, Magistrates, and Council, to maintain Kelvingrove Museum, and "from time to time to erect, fit up, furnish and maintain such new and additional buildings for museums, and collections of natural history, science and art, as they may consider expedient."

The City Industrial Museum was begun without any well defined idea of its scope, purpose, and limitations; but the Edinburgh Museum of Science and Art, originally known as the Industrial Museum of Scotland, and at first intended to be strictly a technological museum, was the model accepted by its projectors. The idea of a purely technological museum was, however, early departed from in Edinburgh, and equally in Glasgow from the first, "City Industrial Museum" was a misnomer. The Museum was indeed all-embracing, and within the limits of four modest apartments, little collections and diminutive specimens of industrial products, processes, and manufactures, natural history, local and general antiquities, and ethnology, were all to be found.

The increased space obtained by the extension did not materially relieve the difficulties of the position. Had it pleased the Town Council to say, "Here we have the future museum

building of Glasgow," and had they given instructions to select and arrange a collection according to the space provided, it would have been proper to proceed on plans suitable to such restricted space. But the inadequacy of the provision being recognised, it was determined to regard all arrangements as merely temporary and provisional, meantime preparing and providing for the time when more ample halls might be erected. Principally by gifts from private persons, and from public institutions, a large accumulation of useful and instructive museum specimens have been made, much of which cannot at present be exhibited. A certain amount of relief has been obtained by transferring to the Corporation Galleries those portions of the Museum collections which have an artistic bearing—the art pottery, glass, metal work, &c., but that relief has been obtained by impoverishing the Museum, and by breaking up continuous series of specimens, and, to some extent, it has consequently resulted in decreasing the educational value and significance of the objects themselves.

The Museum has hitherto depended for its growth almost exclusively on contributions obtained either by begging or by voluntary contribution. No donation or bequest has been received of such outstanding prominence as to give a distinctive character to the collections, and additions which accrue from miscellaneous benevolence are apt to be miscellaneous in their character. Unfortunately, also, it happens that the gifts cannot always be depended on to be precisely of the kind required for the collections. For example, many manufacturers would at once decline to give specimens of their processes and methods which might, in their opinion, convey useful information or hints to rival producers, and thus it becomes difficult to procure accurate illustrations of, and information regarding, technological processes. Others, again, and they are numerous enough, desire to treat a technological museum as a show-room for their manufactures—a cheap and convenient advertising medium for the wares they make and vend. In dealing with the technological part of a museum, the idea of an exhibition too frequently takes the place of that of a museum. In a modern exhibition the purpose of each individual exhibitor is to make himself as prominent as possible, his endeavour is to outvie all competitors in his own class. The objects exhibited by any firm or individual form a complete series in themselves, and their only relations with their neighbours is that of competition. In a technological collection everything is

precisely the opposite of this. The individual exhibitor has no place nor authority ; his name as donor may be acknowledged on label and in catalogue, but what he contributes must be held as strictly subservient to the proper illustration of the processes and products of the department of industry to which his contributions belong. Objects for a museum are, in short, not accepted as illustrations of the activity of separate firms, but as elucidating the methods and illustrating the connections and mutual bearings of the various departments of human industry.

The formation and maintenance of a strictly technological museum is indeed a work of such magnitude and difficulty that it appears to be impracticable except within narrow limits. The subjects to be illustrated are of vast extent and incalculable variety. To illustrate the industries of Glasgow alone, with the raw materials, processes, models of apparatus, and varieties of products, would be a gigantic task, requiring a great building, the expenditure of a very large sum of money, and the skilled attention and supervision of many experts. And, then, the industrial arts of to-day are not those of to-morrow : apparatus become antiquated, processes are superseded, products fall out of commerce, and their place is taken by new or different substances. Thus, constant watchfulness is needed to keep abreast of technical processes and operations, and unceasing changes are needed if the arts as practised are to be truly represented. In spite of all efforts, a technological Museum comes to represent more the history of labour than the present condition of industry, and that it may fulfil such a function in a suggestive and instructive manner, prudent and well-devised selection and limitation of specimens are essential. Models and diagrams of machines and apparatus such as illustrate principles, and such as are of use to teachers for expounding the scientific basis of an industry, or which show the principal stages by which such industry has been developed and improved, should be sought rather than examples of ever fluctuating details of practice. Collections of the raw materials of industry—the animal, vegetable, and mineral substances used in manufactures ; and illustrations of the sources and localities whence they are derived, and the conditions under which they are produced, possess both commercial and industrial interest, and present few difficulties in their exhibition. To teach and illustrate the relation of physics, chemistry, and electricity to all industries ; to show the mechanical principles involved in engineering and

machinery, and to point out the natural history relation of the raw material of manufactures, should be the widest function of any technological museum.

It may just be pointed out in a word that the other departments of a general museum do not present the same difficulties. Any object of art—be it picture, sculpture, metal work, pottery, or textile—if it is truly artistic, conveying some expression of elevated and refined human spirit, possesses an enduring and growing attraction—

“A thing of beauty is a joy for ever—
It’s loveliness increases.”

So it is with objects of antiquarian interest: they illustrate phases in the experience of our race, and with increasing age they acquire only increasing preciousness and significance. Ethnological specimens again illustrate variations in the position and scale of humanity, and these cannot be too carefully treasured as examples of the untutored industries of primitive races whose native industries are with the spread of commerce rapidly ceasing and passing away. So also is it with a natural history section of a museum—views of classification and affinity, and with these nomenclature may change; but the types remain, and the specimens acquired fifty years ago continue as useful and instructive at the present moment as they were when first collected.

The position at which we have arrived may be thus summarized:—We are in Glasgow possessed of a collection of pictures, which, according to the most competent authorities, makes the gallery worthy to rank with the great galleries of the world, excelled in the United Kingdom by the National Gallery alone. These pictures are disposed in a straggling, ill-lighted building, which by no device can be rendered bright and cheerful. The halls are heated by open fire-places, and artificially illuminated by gas; they are subject to extremes of temperature, and no sufficient provision is made to secure the works of art against these deteriorating influences, and against the ravages of the smoky acid-laden atmosphere of the city. At any time the whole property may be destroyed by fire, to guard against which is beyond the power of the Corporation; but even should that danger be averted, the slow but inevitable action of the evil influences above alluded to—smoke, acid fumes, and atmospheric conditions—will eat away and destroy the entire collection. There cannot be a doubt that the M’Lellan

pictures have deteriorated much during the thirty years they have been public property. Another thirty years of such experience would certainly leave them and the other properties little better than wrecks.

In Kelvingrove Park we have a Museum, planted by the chance existence of an old house, in an inconvenient and unsuitable position, yet rendered by the sum which has been expended on it too big to be abandoned altogether, although manifestly inadequate for its proper function. No permanent character has been given to the collection, and the arrangement, upon which so much of the value of a museum depends, has only been of a temporary and provisional character. Little money has been spent on the development of any special section of the museum, and the main characteristic of the collection at present is its miscellaneous nature.

In the Corporation Galleries the city possesses works of art which are objects of interest to the learned and cultured of the whole world. But to a large extent the pictures are above the appreciation of the general mass of the population at the present time, and consequently the institution wants in the elements of popularity. At Kelvingrove Museum there is much to excite the attention and to stimulate the curiosity of the ordinary visitor, but the museum displays little which serves to draw the attention of the investigator, or the man of special knowledge.

The views entertained as to the functions of a museum and art gallery are diverse. By many they are classed as "shows," miscellaneous assemblage of objects to excite the wonderment and gratify the eyes of the multitude. Others grant them a somewhat higher position, and regard them as commendable places of public resort where an idle hour or part of a holiday may be spent with pleasure and profit—convenient places of resort with country cousins and visitors. They look on the body corporate as an accumulator of collections in the spirit of the private virtuoso, as holding up a standard of public taste, displaying in its art treasures the wealth of the corporation, and thereby manifesting a spirit of liberality towards the arts which elevate and refine. A much higher view is that which has regard to the educational value of museum collections—looking to the suggestions they afford to artizans, the stimulus they convey to the inquiring intellect, the hints they afford to the inventive faculty, the models of form, colour, and design they supply to the decorator, and the inspiration

and satisfaction they yield to the artist. Museums that do not aim at affording such help, that do not teach the school boy knowledge which supplements that which he obtains within the boards of his books, and afford to the student and teacher materials necessary for the illustration of their subjects of study, fail in their most important function.

But a certain amount of sympathy must be expressed with all the views of a public museum, from the "show" upwards. While education is the first and highest function of public collections, let us not look at education itself in the narrow scholastic sense. Were museums mere adjuncts of schools and colleges, then their management should have been confided to school boards, and their maintenance charged against the school rates. But the fact that the support of galleries and museums has been recognised as a function of municipal bodies indicates that the popular view of a museum, as a place of public resort, for the service and enjoyment of the public in the widest sense, ought to be a leading consideration in its management. It is the duty of the responsible authorities to popularise such institutions, not by vulgarising or ministering to false taste and mean curiosity, but by as far as possible making the meaning and teaching of every object displayed clear to the humble intelligence and attractive to the dull and uninquiring. There should be no difficulty in combining the elements of popular attraction and educational usefulness.

A primary duty of the authorities responsible for the development of the Glasgow collections is to have the nature and extent of the future accommodation determined and agreed on. On that hinges the question of the space which should be devoted to technology, and the manner in which specimens illustrating industrial arts shall be limited. The conditions under which the art collections are at present maintained renders it undesirable to seek to add materially to their importance. Works of art and many other objects fit for a museum are in their nature unique, and their loss is simply irremediable—leaving the world to that extent poorer. No doubt there exist many things the loss of which would not be much felt, and we do not affirm that the Corporation collections are altogether free from such works. But the pictures which should adorn the walls of the Corporation collection of Glasgow, and the objects of art which should occupy its cases, ought to be of that quality the loss of which would prove a disaster, and in great measure the pictures are of that character.

The urgent want of the Art Galleries and Museum of Glasgow is an instalment of a permanent building erected on a convenient and accessible site, sufficiently isolated to secure it from the risk of fire arising from neighbouring erections. The building should contain picture galleries for the treasures already owned by the city, with some provision for future additions, which supplementary space could be devoted to the exhibition of important pictures obtainable on loan. Next, there should be a hall or halls for sculpture into which may be collected the statues, busts and groups belonging to the galleries, to be supplemented with a collection of casts of the most famous statuary works of ancient and modern times. Halls should also be devoted to the exhibition of works of decorative art, and art industries, and to such of the scientific and practical phases of industry as may be determined on. Local antiquities and objects of historical significance, which should be carefully treasured, also demand a department for their special conservation and display. Further, a great commercial city like Glasgow, whose arms reach out to the remotest corner of the earth, ought to have in its museum a department devoted to ethnology and commercial geography which would illustrate the history of the human race in its manifold phases, and the influences exerted on our fellow-beings by conditions of situation, climate, products, and other external relations. These may be regarded as the principal divisions, apart from natural history, which demand attention, but there are other features which in a detailed scheme should not be overlooked, such as, the provision of a reference library of works on art and science, and a lecture-room, &c.

The various branches of natural history can, with least loss to the whole collection, be isolated and treated as a group apart, forming by themselves a distinct museum. For such a museum the buildings now in Kelvingrove Park afford in the meantime sufficient space. There the natural history of the immediate neighbourhood—the Clyde Valley—its fauna, flora, geology, and mineralogy—should have first attention. With that there should be space given to the full exposition of the natural history of the United Kingdom, and typical examples for teaching purposes of the classes, orders, and subdivisions of the animal kingdom, would complete the collection.

When we make a rough balance of accounts it will be found that the Corporation has not, up to this point, paid a very large sum for the direct promotion of art and science instruction. Leaving

out of account the yearly cost of maintenance, there has been spent by the City say:—

On Galleries property and alterations,	-	-	£35,000	0	0
On the Purchase of works of Art (M'Lellan Collection),	-	-	15,000	0	0
			50,000	0	0
On buildings and fittings at Kelvingrove Museum,	-	-	3,000	0	0
			£53,000	0	0

Against which they have to show of assets:—

Value of Galleries structure and site,	-	-	£42,000	0	0
Art Collections, say	-	-	90,000	0	0
			132,000	0	0
Kelvingrove Museum, building and fittings and collections,	-	-	13,000	0	0
			£145,000	0	0
Balance,	-	-	92,000	0	0
Even deducting for cost of maintenance say,	-	-	25,000	0	0
There yet remains to the credit of the City,	-	-	£67,000	0	0

But for that £25,000 the public have had the use and advantage of the institutions, and it therefore does not form a proper capital charge. This shows a very favourable balance for a non-commercial public undertaking. It may be assumed that were the Parks Trustees to secure a favourable sale of their realisable assets—the heritable property in Sauchiehall Street, which some years ago was valued at more than £70,000, they would have their art collections and Kelvingrove Museum with its contents worth upwards of £110,000 almost free of expense to the public.

Granted a spacious and well-situated site, it may be assumed that the immediate requirements of the art galleries and museum could be satisfied by a sum of not more than £40,000, which would, it is estimated, supply the whole buildings necessary for a generation. In the meantime, the Parks Trustees are not in a position, with their limited rate of twopence per pound, to undertake the whole of that expenditure, and to face as well the annual cost of maintenance of an institution on the scale here sketched. In the question, therefore, how these are to be supplied lies the whole difficulty. It has been suggested that were the Parks Trustees to supply the site, the public might be fairly enough asked to subscribe the amount presently required for building, and

from indications which have already been given, there is some reason to believe that the sum required, £40,000, could be raised without great difficulty. A sufficient site, it is pointed out, could be secured by the Parks Trustees obtaining complete possession of the block in which the galleries building stands, of which at present they own only about one-half. Another suggestion has been made to the effect that the galleries buildings should be sold, and that with the sum thereby realised, a building could be erected in Kelvingrove Park, on a site which would cost the Trustees nothing. Such a scheme avoids the necessity of applying to the public, and it would secure a perfectly isolated structure in an open, airy, and attractive locality. The one objection to the site in Kelvingrove Park is its distance from a large mass of the population, and its inconvenient position for art and other students. Were a site in the Park agreed on, the building would have the advantage of the most ample, open surroundings, and it would be possible either in connection with the opening of the structure, or at any future convenient period, to organise on a great scale a temporary Exhibition of Scottish Art and Industry, from which, with judicious treatment, it is believed, a very handsome surplus might be realised.

Whatever may be the decision arrived at, it is most desirable that no further delay be made in settling the question. During the past fifteen years education has made enormous strides in our midst, large sums have been expended on the machinery of elementary education and school buildings, and the rates levied have been cheerfully and ungrudgingly paid. We are now on the threshold of other important changes in connection with scientific and secondary education; and in the efficiency of all these educational movements the museum of the city ought to be an important factor. It ought to be the centre around which educational institutions should cluster, the store-house whence they could draw the material examples and illustrations required on the lecture-table and in the class-room. Such an influential position, however, cannot be obtained without earnest labour and sacrifice; but a city like Glasgow cannot afford to do its work on a mean scale. It is open for the municipality to elect whether a museum shall be established or not; but having made the choice, it has no right to found such an institution on an insufficient basis, nor to maintain it on a scale which deprives it of its most important and useful function.

VIII.—*On Technical Education from an Architectural point of view.* Opening Address by Mr. WILLIAM LANDLESS, President of Architectural Section.

[Read before the Society, 19th November, 1885.]

The subject of Technical Education is at present engrossing the heads of the Education Department, and one of more importance to the community at large—next to the Education Act itself—has never been before their lordships. The fact of such a system of education being organised ought to be hailed with satisfaction by every one who has the welfare of the nation at heart. The subject of Technical Education, in all its bearings, is closely associated with, and deeply concerns, our profession, as well as the majority of the gentlemen I have the pleasure of addressing.

I find in recent years that this subject has been treated by the late Dr. Bryce, Mr. Sandeman, and also by Mr. E. M. Dixon, the much-respected head of Allan Glen's Institution, of this city. These gentlemen, however, dwelt more particularly upon Scientific and Technical Education in Germany. I propose to look at the subject, to a great extent, from an architect's point of view, and will endeavour to point out the great advantages that would accrue to us, and to the community at large, were such a system of education recognised in our country.

It should be noted first that an empire, and for present purposes our empire, can only be maintained by giving free scope to the greatest variety of methods of education.

In view of this the question is now pretty often asked, are our universities to take cognizance of the technical part of education? Recognising as we all do, that our statesmen, our doctors, our lawyers, our clergy, our literary and scientific men receive their training there, we see no reason why they should not give there the highest training in engineering, and place the students in a

position to receive the greatest artistic, financial, commercial, and agricultural skill.

The class-rooms of a professor should be filled with the flower of the youth of the country, but such should be gathered in *from all classes* of the community. Such a complex machine as modern society, with its manifold wants, makes the organisation of education more complex every day. What is wanted is that public spirit which shall proclaim to every man and woman that education is a privilege, and the more education a man has the more will he be respected.

As you are aware, the subject of technical education applies to all trades and kinds of employment, and in the limited time at one's disposal, all the more as a chairman's address should be concise, it is only intended to deal, and that in a necessarily circumscribed fashion, with the trades we, as architects, are intimately connected with.

We have now reached a period in our history, and we, as architects, feel that we only express the views of the entire community, when we say that efficient workmen are what every contractor wishes, although it is frequently beyond his power to get such men; and as it is daily getting more and more difficult, amidst so much keen competition, for contractors to give their time or that of their foreman *to train apprentices*, as we submit they ought to be trained, it is very evident that proprietors are put indirectly to extra cost, and contractors and architects to additional trouble and anxiety, by the work being, we are sorry to say, in many cases, imperfectly done. The age in which we live, being one of such keen competition, that it should be all but clear, if not quite clear, that schedules are now and again priced absurdly low, certainly too low, having regard to the terms of an exhaustive and carefully detailed specification, and one is often led to ask the question, do such contractors, if such there be, expect to be allowed to get off with work done in a less careful way than the terms of the contract indicate? One is almost forced to conclude they do, else they would not cut out each other so. You will naturally ask, how it is possible to avert this. It is no doubt true there are many contractors who give a strict, conscientious rendering of plans, schedule, and specification, even although to do so may not pay. I go further, and will say that even though the contractors may lose a little by a close adherence to the contract, they do so, as for their own sakes they do not care to put bad work

out of their hands. The difficulty of these gentlemen, you must understand, is very much increased by many, shall we say 75 per cent., of the apprentices not being so *carefully* trained as formerly, and the reason is obvious, namely, the very great haste at which the *public* generally expect *buildings to be erected*. It is quite possible, however, to have speed with efficiency, but such can *only* be attained by the careful, and to a certain extent somewhat slow and methodical, training of the apprentice, as he should first be taught to do his work thoroughly, which takes a great deal of time, and it will only be by continuous and judicious oversight by competent foremen that such can be attained. Another cause of indifferent apprentices and journeymen is, that in times such as we have passed through (and it is with regret we do not yet see much improvement), there are so many changes among the men ; for instance, those not matured frequently require to move about from place to place, being engaged at, say rough work one day and some other kind the next. All this, under existing circumstances, cannot lead to improvement, quite the opposite; and the day, it is submitted, is not far distant when the legislature will be called upon to consider this serious question, and ask themselves what is to be done for the young men who wish to learn the trades carried on in our country. Out of the trades connected intimately with the erection of a building, it must not be thought that the profession complain of any one trade being worse than any other. No. What we submit for consideration is, that all require amendment, and the measures to carry such improvements to a successful issue, will require to be of a drastic nature.

Perhaps it is true, that out of the trades required to conduct a building, although all are of importance, it will be readily admitted that laying drains and plumber work are of the most importance, certainly not second to any other, as on the efficiency of these hangs the healthfulness of the subject. The efforts of the Sanitary Association, as you all know, have disclosed in some of our best houses a state of matters which one would hardly have thought possible; and where the defect happens to be in the drains, it is clear that the laying of these must not be left to mere labourers, and nothing short of rigid inspection and testing of same afterwards will ensure tightness. It is not meant that any special training may be actually needed to lay drains. What we complain of is sheer carelessness and utter want of common sense, and is quite inexcusable.

Coming now to deal with how this instruction aimed at can best be carried out. It is suggested to erect large buildings where the trades could be learned under competent foremen for each department. These technical schools would require to be aided by the State, and conducted under its supervision. It would require to be law that no boy under, say 12 years of age, could offer himself as an apprentice, and such a boy, whether of that age or not, could not so offer himself unless he had a certificate setting forth his having passed a certain standard under the School Board. The term of apprenticeship to be served, it is thought, should be not, in any case, less than five years, and at the end of that time the apprentice would be under an obligation to subject himself to an examination, which would set forth the degree of efficiency to which he may have attained. Such certificates of competency would be marked 1st, 2nd, and 3rd, as the case might be, and the applicant would, of course, rank according to such class. A very natural question may here be asked, should this be carried out, where are the boys to come from who at present assist in the joiners', masons', and other contractors' yards? This might be arranged as follows:—That the masters only retain these boys, teaching them of course as much as possible, for, say a year, or at most two years, as by that time the boy would be in a better position to judge whether he would remain at the calling or not; and besides, he would have the benefit of not only seeing articles made, and assisting in his own way to accomplish this end, but would have the benefit of more clearly realising what the particular trade is to which he had either temporarily or for his future life attached himself, as the different parts of the building would proceed before his eyes. It should be remembered, further, that a great deal of the rough part of a mason's or joiner's work is at present performed by lads, at too early a period in life, and more of it should be done by a skilled labourer; and although the expression at first seems amusing, it is surely possible to get even labourers improved, and brought to understand, if taken in hand at not too late a period in life, that there is a neatness, or at least some approach to such, even in the work they get to do. Administrative skill is what has often appeared to some members of our profession to be somewhat wanting in the conduct of many of, say our larger buildings; and all this, it should be borne in mind, points to economy, as it is quite clear that the systematic and well-managing contractor will not only turn out more satisfactory work, not to speak of the

pleasure which such a state of matters would be to the proprietor and architect, but at more profit to himself. As to the working of such industries, as previously stated, they would require, to begin with at all events, considerable support from the State, as it could not be expected that the parents of many of the boys could afford to pay for instruction of this kind. Having just got clear of their school charge, they naturally expect the boys to earn something. The work to be done by these boys can, of course, be utilized and turned into money, such as the hewing of rybats and sills for masons, string courses, &c., &c. This would all diminish the crush and inconvenience in narrow thoroughfares particularly during the erection of many of our city buildings, as the material could be delivered ready to erect. In joiner work, windows and doors could be made and architraves run, &c.—of course the latter is already done on a large scale. Such establishments could be connected with, or adjacent to, any of the more important of our saw-mills or railway depôts.

To give an illustration of a trade which cannot well be taught in a technical school, plastering is possibly the only one, and the schools which form the subject of this paper, and which we are advocating the erection of, could not well be devoted to the training of apprentices as to how to put on plaster; but bear in mind that modelling, and what, I need hardly say, is more important, could be taught. This is very much needed. It may be stated that in Kent Road School in this city the Board will not only have drawing and painting rooms, but modelling rooms, all of unusual dimensions, and very completely equipped.

In connection with these technical schools, it would of course be necessary that instruction be given in chemistry. A knowledge of this science would be useful to any of us, and much advantage would be afforded apprentices to plumbing, brassfounding, glazing, and plastering, by having received instructions in this science. To instruct school boys, as far as our present arrangements admit, would be to give them an insight into some of our large manufactures and works of every kind; and from time to time they could be requested to write an essay on what had been brought under their notice. The longest life is not long at the best, and all of us, less or more, feel the want of not knowing enough about many things that come under our review. This remark applies specially to those who follow our profession, as so much is expected of an architect. There is no doubt as the world advances it will become

more and more difficult for the youth of the country to find employment, and it is education alone which will pave the way to better employment for a larger number than has been the case in the past. Our profession is interested to a very great degree in anything that has for its object the advancement of the workman, to make him more intelligent, so that he may have a thorough idea of his work and really to realize for what purpose he is there.

At the outset allusion was made to Allan Glen's Institution; and as the instruction given there is productive of so much good, and as it is the only institution of this kind here, you will kindly allow me to supplement what has already been said, and that with a view of letting you know as to the scope of the instruction given. Such instruction is determined by the age at which pupils leave school to begin their apprenticeship; and the technical training received must be preceded, and, as far as possible, accompanied, by a thorough course of instruction in English and those other subjects that belong to a liberal education. A school such as the one now in question lays much stress, for instance, upon mathematics, physics, chemistry, and, last, though not least, drawing; and treats such subjects as part of the curriculum of study of every pupil, whether intended for industries of a mechanical or chemical nature. It need hardly be stated that a chemical laboratory and a school workshop are of necessity two of the class-rooms in such an institution. I am informed, through the courtesy of the esteemed Headmaster of Allan Glen's Institution, E. M. Dixon, Esq., that the experience of the effectiveness of this institution testifies that lads of 15 or 16 years of age can acquire in two years (during which time they spend not more than one half day weekly in the workshop) at least as much manual skill as is usually acquired by lads in the first two years of an ordinary apprenticeship. This statement, it may be added, is made with a full consciousness of the charge which it implies of gross waste of the time of apprentices in the engineering trade especially. It should, however, be added that, in making such a statement, there is no intention whatever of charging this apparent, it may be to some, but absolutely real, waste of time against the proprietors of, say, our largest engineering works. The want of suitable schools is the chief cause, if not entirely the sole reason, which can be given by way of explaining the serious waste of time and talent that is going on. Some of the lads trained under Mr. Dixon who entered engineering shops have been found, to the astonishment of the

proprietors, quite able to go at once into the drawing office, which, as a rule, only clever apprentices become able to do at the end of their apprenticeship; the experience being that a systematic and methodical and painstaking course of instruction in drawing, combined with suitable workshop exercise, is, in almost every case, capable of turning out a lad at, say, 17 years of age able to interpret and execute technical drawings of considerable complication. A pupil is not allowed to make a mere copy of a drawing, but is, which is of far more importance, trained to make a proper scale drawing from a rough dimensioned sketch, or of a machine taken from measurements made by himself.*

Passing from the notes on instruction given in Allan Glen's Institution, I proceed now to speak of drawing; and the reason for proposing to give this so much prominence is not only because architects should be able to draw, but that it is now pretty generally conceded that every boy should be taught this most important branch of education.

As an indication of the rapid rate at which instruction of a more or less technical character is advancing, we may notice the action of School Boards generally, and of the Glasgow School Board in particular, in the matter of *drawing*. The educational endowments of the country are also being, to a considerable extent, turned in the direction of technical instruction; as witness the proposed application of the funds of Heriot's Hospital to the erection of a school of the same type as the Allan Glen's in this city, though on a very much larger scale, and to the extension of the present Watt Institution in Edinburgh; and the proposal in a scheme now before Government to put all the technical education in Glasgow under one managing body.

The designer, it may here be stated, is not made for drawing and colouring alone, he is like the rest of us, a complex being—a mind to direct his hand and eye, a spirit to feel and sympathise

* To show you to what extent the Directors of Allan Glen's Institution are realizing the importance of this system of technical education, which they have done so much for, I am informed by Mr. Dixon that they are about to increase to a considerable extent the size of their premises, and, when such additions as those under contemplation are made, they will be in a position to give a very thorough technical education to, say, 600 boys, supplying them not only with theoretical instruction, as a foundation for future technical studies, but also with a considerable amount of practical instruction in laboratory work, in drawing, and in the working of wood and metal.

with what is beautiful in form, colour, and association. If the teaching is systematic the pupil will have learned that every figure he has drawn is built and founded on a *geometric plan*. The pupil will doubtless be taught to regard architecture in its largest sense as the basis of all design, and will be trained in the classic orders, their parts, construction, and proportion, the various modifications on these orders brought about by the national development in Italy, France, and England, specially the proportions and decorations of doorway and window openings, the theory and practical application of all mouldings, construction in various materials, stone, brick, terra-cotta, timber, and iron. Next in importance is it that the pupil have a knowledge of ornamental forms, such principles being reduced to their simplest expression. In the largest sense, I would have you remember that colour cannot be taught: a colourist, like the poet, is born, not made. He will, while still young, do generally everything that is right, and rarely anything wrong, and, moreover, will in all likelihood be unable to say why he does it. No method of study can endow *everyone* with taste, and if this gift be found in the student, the greatest care should be taken not to *spoil* it, but rather to cultivate and encourage it. Drawing is all-important: to draw is to create. Drawing is the body and soul of art, colour is its garment. It is sufficient for present purposes to say that the student's career in drawing should divide itself into three heads:—1, Elementry; 2, Historic; and 3, Practical.

Elementary drawing is most important, because of the difficulties to be overcome in thoroughly capturing the student's whole attention.

As to historic, this study—I do not attempt to go into details—refers to diaper and arabesque ornament. With regard to ornament, as those around me are aware, nothing gives greater pleasure than a scroll done with *care*, and time spent in obtaining mathematical exactness is *lost*.

With a view to avoid this, the student ought to be allowed latitude in the size, so long as the scroll is defined with grace, and expresses the same feeling as the original.

Then, as to the practical side, in this study of course are embraced the sense of fitness that form and colour have in the situation in which it may be proposed to use the one or the other; as, for instance, in a badly lit apartment you wish a cheerful tone given thereto, and in one overlit a subdued effect is wished. The artist's

mind should conceive and carry out what is appropriate, and suit the colour to the requirements.

Experience, which now appears to be within the grasp of many in early middle of life, alone can show the system of education best adapted to the various grades of persons engaged in the industries of this country. For example, in medicine, engineering, in military and naval warfare, and in law, systematic technical instruction has always been given, less or more, for many years to those preparing to follow any of those pursuits; whilst, on the other hand, the technical education of artizans proper, as well as of persons engaged in our manufacturing industries has, until very recently, received little or no attention. During the last few years, however, no educational topic has been brought more prominently before the public, and the progress made has been considerable. The action of the City of London Guilds has done much to attain such a desirable state of matters.

Amongst the conclusions which may be said now to be clearly established is the common sense view that all technical education must rest on a basis of sound primary instruction, and that technical education will avail little where such instruction has been neglected. One of the first problems to be considered by the technical educator is to consider what is to be the character of the education to be given at our public elementary schools, in which nearly the whole of our artisan and labouring population receive their education. All admit that the three R's—Reading, Writing, and Reckoning—are the main subjects in which a scholar should be grounded; but it is now just as clearly shown and demonstrated that the three D's—Drawing, Drill, and Adroitness—must be included. With regard to drawing, I do not mean here power of sketching, but linear drawing and drawing to scale.

It is not, I am afraid, generally known to how limited an extent drawing is taught in our elementary schools. In the years 1882 and 1883 not more than 25% of the scholars attending school received the instruction advocated here.

Further, technical education, in all its stages, involves the practical teaching of the principles of science.

In the earlier stages of science teaching such knowledge was sought to be imparted by familiarising the pupil with the forms and properties of external things, and in the later stages the faculties were developed by bringing them into direct relation with the processes of nature in investigation pursued in the chemical,

physical, or mechanical laboratory. The necessity of science instruction for those to be employed in manufacturing industries, as well as for those who intend to follow any of the constructive arts, is now a settled point in technical education.

Science teaching to convey to the youth its useful discipline and power, must be more practical than it has hitherto been. In other words, the pupil should not only be brought face to face with nature, but into hand-and-hand contact with her processes, and instead of assuming data for mathematical investigations, these data and contents will require to be determined by himself in the course of his ordinary work.

The importance of the knowledge of French and German is also daily becoming more and more recognized as a part of one's educational equipment, and the necessities of the technical student will doubtless, in the course of time, result in a change of system which shall enable a boy, at the close of his school career, to speak, at all events read, a foreign language with tolerable ease. I now ask you to consider for a little the relation of workshop practice to general instruction, and first beg to draw your attention to the Nottingham School.

In the mechanical technical schools of Nottingham attention has been given mainly to three classes of students:—(1) Those who have received a fairly good general education; (2) those consisting of trade apprentices who can attend schools only in the evening; and (3) those students who may be considered a higher grade of the second class.

For the first there is instruction in mathematics, physics, chemistry, drawing, theoretical and applied mechanics, and during the intervals between those classes the students are employed in the workshops, which consist of carpenter and pattern makers' shops, smithy and foundry, turning and erecting shops, with lathes, &c.

For the second class the lectures of classes are the important feature, and the instructor can illustrate the instruction sought to be imparted by passing to the workshops.

In the third the workmen have attained, in many cases, considerable proficiency, and many may be earning good wages. This class generally seek to study some special branch which they have not had an opportunity of embracing during their apprenticeship; for instance, the more difficult questions connected with roof construction, geometrical staircase work, and chiefly, and

above all other things, they should desire to get fully conversant with the special industry of any locality ; and such should, of course, be made the chief subject for classes in this our city. There is, further, another important feature of a school of this class, viz., the having a museum. This ought to be well equipped, and should comprise a collection of kinematic models, as well as models illustrating applied mechanics, including the strength of materials. The testing department in engineering schools is of the highest importance, and the results obtained with such a machine should form the basis of instruction.

I now proceed to give an indication of a few continental schools which have carried on good work.

In Paris, and some of the other cities in France, workshops have been introduced into some of the elementary schools with very satisfactory results. Belgium has also followed ; whilst for many years the Ambacht schools in Holland have proved of the greatest value to the workpeople. In Germany the same development does not exist, but drawing is generally well taught. A good many details have to be arranged before embarking upon such a course of education. In the first place, the age when the manual works ought to be commenced, the class of teachers to be employed, and the character of the work that should be cultivated and encouraged. It may be taken for granted that, to begin with, the instruction aimed at should be disciplinary rather than professional, having as the main end or object the imparting to the pupil a general knowledge of, and familiarity with, the use of the tools needed in following out the kind of trade the pupil may care to follow. When the difficulties which the complete mastery of the three R's and of drawing presents are taken into account, the pupil should not embark on technical education until the fifth standard is entered.

The greatest difficulty which presents itself to our mind, and where great differences of opinion exist, is as to the value and real worth of apprenticeship or trade schools, such schools being those where the pupil is taught the trade, or in which definite trades are taught, and the general education at the same time continued. A well-known example of such a school is "L'ecole des Apprentis" at Paris. Pupils leaving this school are able to gain a living as locksmiths, engine-fitters, and philosophical instrument makers, and can earn wages varying from 2s. 6d. to 5s. per day. Examples of such schools are also found in Austria, Germany, Russia, and the

United States, but as yet there are none in this country. The pupil will thus learn the different processes more speedily, having the advantage of the direct supervision of a foreman thoroughly qualified, such a foreman in a going business not having the time at his disposal. There are many trades where machinery is not used on a large scale, and smiths and carpenters, it is submitted, would receive under this system of technical education a thorough knowledge of the trade to be followed. In the training of young persons of either sex for art industries, in the exercise of which machinery is very slightly used, the trade school possesses very distinct advantages. For decorative artists, wood carvers, wood engravers, chromo-lithographers, glass-stainers, and designers for different trades, the system of education pursued on the continent has much to recommend it.

In order that these schools may be successful, the advanced pupils should be employed in producing saleable goods, and be brought into contact with the commercial aspect of the work in which they are engaged. This naturally increases the interest they have in making the article.

Amongst the difficulties in arranging special courses of technical education, are the extreme division of labour and the numerous branches into which each trade is subdivided — for instance, printing, coach-building, and watchmaking are the names not of one industry, but of several, and technical education is not at the outset, whether it is practicable or not, to arrange courses of instruction for those engaged in separate divisions of the same trade. As every one knows, it is only in a limited department of a trade that a workman can ever expect to be proficient. It will at once be conceded that this wider instruction may not make a man a more qualified workman, although by teaching him to think, and by educating him through his trade, he may thereby become more generally intelligent and competent, and manifestly of greater use to society. If a person is to be trained as a metal-worker or glass-stainer, what is the best education he can receive? If to make designs for weaving, calico printing, for pottery and porcelain, for lace or wall-paper, what special instruction ought he to receive? It is well known that although a design may be beautiful it may not be adapted to the material in which it is to be worked. The designer must therefore be something more than an artist, and the question is how and where he can obtain this additional knowledge. Strange to say, in Paris, from which city

designs for all kinds of material and fabrics, until very recently, were almost exclusively and even now are frequently purchased, industrial art teaching is very seldom taught. Men are trained to be artists, rather than designers.

I am glad to learn that the excellent head-master of the School of Art and Haldane Academy devotes his attention especially to the instruction of designers. Mr. Newbery's aim is not to produce designs, but to make designers.

In the weaving branch (the only one as yet established by the Glasgow Technical College), the want of a knowledge of the principles of design is much felt, and the students there are becoming more and more alive to the necessity for acquiring it, although the school, which is now in its 10th session, has done good work, and the attendance yearly (50) bears testimony to its instruction being duly appreciated notwithstanding. The promoters of this school feel that the efforts now being made to give drawing lessons to the youth of the city may enable them to insist upon a knowledge of drawing as a condition of entering this school.

There is another question to which no definite answer has as yet been given, and that is the extent to which it is desirable that the designer and the worker should be united in the same person. In olden times the artist and the artizan were one. Should we be likely to get better work if these two classes were again united?

I would ask you to consider for a single moment the powerful effect of music on the scholar and workman, and it is possible you are struck with my introducing this element into the address. I do so, not only because I care for music personally, but chiefly, and above all, because I hold that as a means of culture it ought to be kept to the front, and, further, as a form of special knowledge, of course the latter, if proficiency is aimed at, cannot be attained without a vast amount of labour. What I wish to convey, however, is chiefly this, the great power for good it can exert over us all and would remind you that music should be distinguished in two different capacities (1) as a means of culture, and (2) as a form of special knowledge. In its first capacity it ought to be included in the three R's as a necessary element of mental culture. The actions of an efficient workman should or ought to be all in harmony, and his life a hymn of praise. There is no form of art which, like music, can beautify the dullness of school life. Is music not an art? Is it not eminently attractive? It inspires

one with a delicacy of feeling, and brings about the moral improvement of the working classes.

In the time at one's disposal not more than a passing glance could be given to many points, and I cannot but feel how imperfect many of my remarks and comparisons may have been. I trust, however, that the importance of this vast subject will be recognised, a subject which, under proper government discipline, and the judicious mapping out of the various studies necessary to equip the youth of our country with a thorough knowledge of the calling to which he may elect himself, will eventually be stronger to us than armies, and as years roll on be the means of raising thousands of our fellow-countrymen, to take the most moderate view of it, from a state of ignorance and apathy to admire much that is around in nature and in art, to have some pleasure in their leisure hours ; for it must not be forgotten, by the way, that the workmen of to-day have, it is thought, too much time on their hands, certainly too much for the way many spend it, and the more education a man has the more not only will he be respected, but the more he will respect himself.

Gentlemen, allow me again to thank you for the patient hearing you were good enough to accord me, as also again to acknowledge my indebtedness for the position in which you have been pleased to place me ; and I hope you will all give me the benefit of your experience in carrying to a successful termination the session upon which we have now entered, and which, to judge from the syllabus, I do not doubt will be one of the most successful we have had.

NOTE BY MR. LANDLESS.

Since delivering this address I have visited the Glasgow College of Science and Arts, and find much good work being done amongst the class most requiring technical education, viz., the sons of our foremen, managers, and owners of works. There are about 70 day and 850 evening students at present. At the last two examinations for Whitworth Scholarships, eight of the successful candidates were students of the college.

IX.—*China's Northern Dependencies and Colonial Possessions.*

By JOHN DUDGEON, M.D., C.M.

[Read before the Society, 27th January, 1886.]

IN 1884, my friend and fellow-labourer in China, the Rev. Dr. Williamson, read a Paper before this Society on the Physical Geography of China. His intimate knowledge of the subject, derived from personal journeyings and a long residence, enabled him to present a paper full of interest and important information. He has treated of China Proper, in regard to its physical geography, its wonderful means of communication by means of its great rivers, lakes, and highways. He discoursed to you of the nature of the soil, pointing out that most peculiar feature of it—the loess, and speculating as to its origin. Besides referring to the meteorology of the country, he described its food products, textile fabrics, oil producing plants, and dyes. He entered also upon a consideration of the geology, describing its rich coal measures, and on this subject he was well qualified to speak with authority. He touched too upon the trade routes, the origin of the Chinese race, and concluded by considering the bearing of all, both upon the future of China, and that of other countries. He has left little that would perhaps prove eminently suitable, however otherwise interesting, to bring before you regarding the "Eighteen Provinces," as China Proper is commonly designated by the people themselves. No paper could have been more suitable before such a Society in this large commercial centre, where shipbuilding and iron industries in general must stand in a closer relationship to the development of China than perhaps those of any other city in the world. Already, and for more than a quarter of a century past, Clyde-built steamers plough her rivers and seas, and if only our Government, through its Minister and Consuls, would but exert itself a little more for its nationals in China and other countries of the East, and throw aside a good deal of the *haute politique* and red-tapeism, there is no fear that our merchants, with a fair field and no favour, which they can hardly be said to have at present, will fail in securing an important share in the prospective development of the vast material resources of this Great Empire, the greatest,

the oldest, the most peaceful, industrious, sober, frugal, and docile that has ever existed on our globe.

China Proper is only one of the three divisions into which the Chinese Empire (Ta-tsing Kwoh—Great Pure Kingdom) is divided, the other two being Manchuria and the Colonial Possessions. This, it will be observed, does not at all embrace the tributary nations of China, which, excepting Corea in the north, and the Loocoo Islands in the Eastern Sea, now claimed and for some years owned by Japan, are all situated in the south, and embrace the various States of the so-called Indo-China peninsula. We shall have a word to say of these tribute bearers before we close.

On account, therefore, of the interest attaching to these northern dependencies of the Chinese Empire, it has struck me that it would not be unsuitable to draw your attention briefly to these little-known regions. The paper, moreover, may supplement Dr. Williamson's on "China Proper." Manchuria includes all north of the Gulf of Liautung as far as the Amoor, and west of the river Usuri; the Colonial possessions embrace Mongolia, Ili, Kokonor, and Tibet. In Peking there is a Colonial Office, known as the Lifanyuen, or Court for the Government of Foreigners. As we, and the inhabitants of all foreign countries who do not choose to range ourselves under the renovating influences of the celestial dynasty, (the country and people are incorrectly designated by this oft-used, and, to them, unknown term), are included in this office, a word regarding it may not be unacceptable. It has "the government and direction of the external foreigners, orders their emoluments and honours, appoints their visits to court, and regulates their punishments, in order to display the majesty and goodness of the State." It has the superintendence of all the wandering and settled tribes in Mongolia Kobdo, Kuldja, and Kokonor. These are called *wai-fan*—external foreigners—to distinguish them from the *nei-fan*, or internal foreigners, which include the tributary tribes in Szechuen and Formosa. There are also *wai* and *nei-i*, or external and internal barbarians (a word no longer by treaty stipulation allowed by the western powers to be applied to themselves), the latter comprise the unconquered mountaineers of Kiweichao or Miautse, and the former all foreigners, and ourselves among the rest, who are generally spoken of as "foreign" and "red-haired devils." This office regulates the government of the nomadic peoples and restricts their wanderings. Its officers are all Manchus and Mongols.

These Northern Dependencies are the least known parts of the Chinese Empire, and indeed we may say of Asia generally. The desert of Gobi may now emphatically be said to be the least known part of the globe. This desolate region, and that of the Kwen-lun mountains in this quarter, is the favourite arena for all the genii and monsters of Chinese legendary lore, and is the Olympus where the Buddhist and Tauist divinities hold their mystic sway.

Let us first glance at the mountains, rivers, lakes, and other outstanding objects of the region under review. The great range of mountains running along the north frontier is the Altai range, with a course of 2,000 miles. In its course it has received several names. The Chinese call its eastern part *Wai Hing-an*, the Russians Stanovoi. This latter name gives place to Daurian, west of the confluence of the Songari with the Amoor, as far as Lake Baikal or Northern Sea in Chinese. This lake is 600 miles from the Pacific or Oriental Ocean, and this entire stretch is now all included within Russian limits. To the west of the Baikal the chain takes its proper name, Altai or Golden mountains, the Chinese *Chin Shan* having the same signification. Near the source of the Selenga, which flows into the Baikal, this range divides into two nearly parallel systems running east and west. The southern one is called Tangnu, and lies mostly in Mongolia. These mountains finally join the *T'ien-shan* or Celestial mountains in the province of Kobdo, and further west unite again with the Altai, where China and Russia join near the Kirghis steppe. Another chain is the Belurtag, Tsung-ling, or Onion mountains, from the bluish tint like that of onions, according to Remusat, or from the abundance of onions found there, according to Klaproth. The Belurtag separate Songaria from Badak-shan, and connect the *T'ien-shan* and Kwen-lun. To understand still better the Central Asian system of mountains, we may suppose the mountain knot detached from the Hindoo Kush in south-west Turkestan, the Belurtag would then issue from this central knot on the north, the Himalāya (abode of snow) on the south-east, and the Kwen-lun on the east. The Altai, Belurtag, and Himalāya may be said to enclose the Chinese Empire on the north and west or inland frontier. Along the Corean frontier there is the Chang-pai-shan, or long white mountains, a spur of the lower range of the Sihhihteh mountains east of the Usuri.

Of the chains within the northern part of the Empire there is the *T'ien-shan*, Tenghiri of the Mongols, with precisely the same

meaning of "heavenly." It rises from the Belurtag east through Ili, dividing into north and south circuits. At Barkal the ridge meets the desert. The country between the Altai and Tien-shan is much broken up by spurs or connecting links. The prolongation westwards of the Tien-shan is called Muztag which runs into Kokand. Parallel with the Tien-shan is the Kwen-lun, Nanshan (southern mountains) or Koulkoun range, called also T'ien-chu, i.e., "heavenly pillar," corresponding precisely with the Atlas of China (the occipital or back or pillow bone of the head is also so designated in Chinese anatomical works). It rises from the knot of the Hindu Kush (how frequently the word Kush occurs in names of places in Asia, e.g., Cashmere, Calcutta, Calicut, &c., referred by some to the grandson of Noah, whose descendants are supposed to have peopled these regions) runs east through the table land, and divides in part of its course Tibet from Gobi. It divides about the middle of its course into several ranges, such as Burkhan Buddha, Shuga, Bayan-kara, and the Tangli mountains, which all merge in the Yün-ling, or mountains of the cloudy south, all declining south-east through Kokonor and Szechuen. A northerly group runs in a northerly direction from the sources of the Hwangho (not to be pronounced Ho-ang Ho, which has been caused by the want of a *w* in French, and all Chinese words, it should be remembered, are monosyllabic) or Yellow River and pass through Kansuh and Shensi to join the *Inner Hing-an* near the great bend of the Yellow River. These groups are called Altyntag, Nanshan, Inshan, and Alashan (shan is the Chinese for mountain). Near the bend of the Yellow River begins the *Inner Hing-an* or Sialkoi or Soyorti range, which runs north-east till it reaches the *Wai Hing-an* (*nei* and *wai* in Chinese mean inner and outer). The Kwen-lun and Burkhan Buddha range define Tibet or Bod on the north as the Himalāya do on the south.

The great desert of Gobi or Sha-moh, both expressions meaning sandy plains (one interpretation makes Gobi refer to the stony and Sha-moh to the sandy tracks of the desert) lies between the Tien-shan and Kwen-lun range. This waste is about 2,000 miles long and its average breadth about 400. Within the mountain ranges which define it, its area exceeds a million square miles, and few of the streams rising in it find their way to the sea. It is not all a barren desert. The great altitude of most parts may have as much to do with its unfruitfulness as the nature of the soil. A fruitful tract along the southern side of the Celestial

mountains contains nearly all the Mahomedan towns of the southern circuit. The river Tarim flows through this tract to Lobnor or Lake Lob, and along the banks of the Khoten River there runs a road from Yarkand to H'lassa. This district is called *Han-hai*, or Dry Sea, by the Chinese, from the mirage appearance it presents. It is sometimes called the Desert of Lobnor. The rest of the Gobi is nothing but desert, and in winter the north-west winds coming from Siberia and the Gobi, carrying frozen particles of snow and sand, make this wind a bitterly cold and disagreeable one to Northern China and to us at Peking. These winds, the cloudless sky, the bare saline soil, and great altitude, make this region one of intense cold. Even in the height of summer, in the agricultural parts of Mongolia, a sheepskin is urgently needed the moment the sun sinks under the horizon. The moving sand hills of the desert are a great source of danger to travellers. The road from Urga to Kalgan, a gate in the Great Wall, and across which the entire Russian trade is conducted, crosses the eastern part of this desert. It is, however, watered and clothed with grass during certain seasons, and hence the necessity of travellers selecting that time when their camels can find pastureage. This road is 660 miles, and has 47 posts placed along the route. The region bordering upon Chihli (*i.e.* the province of Direct Rule, the Metropolitan province of China), is called *Tsao-ti*, or grass land, and is inhabited by a Mongol tribe called Chahar. On the north-east borders of Gobi are some large streams which enter the Amoor. The general features of Gobi are less repulsive than the Sahara, but more so than the Siberian Steppes or the Pampas of Buenos Ayres. Pumpelly, the American geologist, who visited China over twenty years ago and has written on her geology, considers the whole of Gobi as having been at one time part of a great ocean, which in comparatively recent geological times extended to the Caspian and Black Seas, and the Ural and Inner Hingan mountains, and was drained off by an upheaval whose traces and effects can be detected in many parts.

The Hwangho—China's Sorrow, as it has been poetically and plaintively called from the frequent inundations, for hundreds of square miles, caused by its overflow—rises between the Shuga and Bayankara mountains, about 100 miles from the source of the other great river of China, the Yangtse. This river is marked by its tortuosity. Its first course is for 30 miles South, then 160 East, then nearly West 120, winding through gorges of the Kwen-

lun; then it flows north-east and east to Lanchanfu, the capital of the province of Kansuh, having flowed in its devious course about 700 miles. At this city it turns northwards along the Great Wall for 430 miles, till deflected eastward by the In-Shan on the edge of the plateau, and incloses the country of the Ortous Mongols within the great bend. It then runs south between the two provinces of Shansi and Shensi for about 500 miles, till it enters the great plain, having run 1130 miles from Lanchao. It runs through the loess region which abounds here, and from which it has doubtless derived its name, the river carrying to the ocean immense quantities of this yellow loam. Its course is very rapid in descending from the Mongolian plateau. In this part of its course it receives no tributaries. At the south-west corner of Shansi, the river Wei, a stream flowing 400 miles from the west, its largest affluent and a navigable river, flows into it. The area of the basin of the Hwangho is calculated at about 475,000 square miles, an area somewhat less than that of the Yangtse. The Yellow River is not over 1300 miles in a direct line from its mouth, but its numerous windings almost double this distance. This river is not navigable for large foreign steamers, like its great rival, for hundreds of miles. It is subject to great differences of level in winter and summer, and the silt deposited along its lower-level course has choked its mouth, raised its bed, and the dykes built along its banks to the east of Kai-feng-fu make it still more subject to overflows. The floods have thus filled up the channel, and forced the waters back over 500 miles to Honanfu, where the land is low; and the river, through its reffluent waters, has gradually worked its way through creeks and marshes into the River Wei (another Wei) on its north bank, and thus the Yellow River has deserted its old channel through the province of Kiangsu into the Eastern Sea, not far from the mouth of the Yangtse (like friends beginning and ending life's course in close juxtaposition, although separated in their middle course by a great distance) into a north-east channel into the Grand Canal and the Ta-tsing river, which flows into the Gulf of Chihli (or as it is written Pechele, i.e., North Chihli, the prefix is unnecessary). We have, therefore, in the case of this river a conclusive argument against dyking a river's banks to restrain its floods. The river has now, within the last twenty years, reverted to the channel it occupied about fourteen centuries ago. Contrast this river with its more tranquil and useful rival, the Yangtse (incorrectly written in Chinese, and hence translated, "Son of the

Ocean," in other respects a truly poetic designation) flowing also from the Kwen-lun range, and running 3,000 miles, reckoning all its windings, and more than 1,800 miles in a direct line from its mouth to its source. The Yangtse is steady and deep in its lower course, carrying the largest vessels afloat from Nanking to the sea, and our ocean tea steamers to Hankow, 400 miles up the river, and available for rafts as far as the western confines of Szechuen, and for boats for 1,700 miles from its mouth. Its banks are high enough, so that when in flood, as the river rises thirty feet, they are seldom injured. No two mighty rivers could be more unlike.

The lakes in this region north and south of Gobi are all salt. They receive the waters of the streams within their own isolated basins. None of these is so large as the Ural Sea, but collectively they cover a much larger extent. Geographically and geologically this region would afford interesting research. Col. Prejevalsky, the Russian traveller, has already done and is still doing good work in this region. Lobnor, one of the largest lakes, is said to be a great marsh, 75 by 15 miles. The Kokonor region is full of lakes, and *Tsinghai*, or azure sea, is the common Chinese name for this division. The Tengkiri-nor in Tibet, north of H'lassa, is the largest sheet of water within the frontiers.

The Great Wall or Wan-li-chang-chēng (myriad mile long wall), built by Tsinchih-wang about the time of Alexander the Great, demands a brief notice as separating China Proper from the northern dominions, now included within the empire since the accession of the present Manchu dynasty to the throne of China. The wall was built to protect his dominions, the "Inner" or "Flowery Land," from the incursions of the northern tribes, one family of which is now China's master. This emperor, who destroyed the feudal system, and was the burner of the classic books and 500 of the literati, wishing thereby to be known to posterity as the first emperor, built and united portions of this wall already in existence, and extended it along the whole northern frontier. It was finished B.C. 204, and it took ten years to build, a million men, it is said, having been employed in the work. This gigantic undertaking, which I have several times visited, remains at least as an evidence of the industry and perseverance of its builders, whatever may be thought of the folly of scaling heights which are of themselves impregnable. It commences at the Gulf of Chihli with a palisade, and runs over high and most inaccessible mountains and scales precipices to Kia-ü-kwan, its termination in

Kansuh, through which the road passes to Hami and the west. In all ages this has been the route between China and the west. Its entire length is 1,255 miles in a straight line, or 22½ degrees of longitude, but its turnings and windings make it 1,500 miles. The eastern portion is the most substantial. Between the provinces of Chihli and Shansi there is a loop wall. This inner wall is of much more recent construction, and is consequently in a much better state of preservation. In the western part of the outer wall it is often not more than a dyke or mound of earth or gravel. The eastern part is of brick retaining walls, parapet and terre-plain, with granite foundations. The inner wall is of granite retaining walls, with brick parapet and terre-plain, both filled in with yellow earth. It is about 25 feet broad at the base, 15 at the top, and varies from 15 to 30 feet high. The city walls of Peking are in themselves in every sense more imposing. The thinness of the parapet of the Great Wall has been taken as a proof that cannon were unknown at the time it was erected. There are brick towers, independent structures, at very frequent intervals about 40 feet at the base, diminishing to 30 feet at the top. Some one has said that in taking a rapid survey of our globe this wall is the only artificial structure that would strike attention. The finest point from which to view the wall is at Ku-peï-kow (old north gate), about three days north-east from Peking, where it is very imposing, and where 20 miles of it can be seen stretching over mountains 5000 feet high. At present it is a mere geographical boundary, and the gates at the passes have been allowed to fall into disrepair. The wall is most visited by foreigners at Nankow, the southern opening of the pass, a wonderfully rough but busy commercial pass, 15 miles long, which leads up to the wall at the top of the pass from the great plain to the first terrace above it. In this pass is a remarkable archway with a Buddhist charm in six languages, Mongolian, Chinese, Oigur, Tibetan, Nü-chih, and antique Devanagari, erected in 1345. This is the only remnant extant of the Nü-chih language—the speech of the Kin Tartars, who ruled China from 1118 A.D. till they were expelled by Genghis in 1235. They were the ancestors of the present Manchus. Two graves of these monarchs exist in a hill 50 miles south-west of Peking. This language has been deciphered by Mr. Wylie, a well known sinologue.

A reference to the Amoor and its affluents will complete all we have to say of the rivers of these northern regions. The

Amoor (great river), which has for its synonyms Saglien-ula in Manchu and Hei-lung-chiang in Chinese, both meaning "Black" or "Black Dragon River," drains all the country north of the Chang-pai-shan of the Chinese as far as the Stavanoi mountains. It has many large tributaries, and together they drain the north-east slope of Central Asia. It is made up of the junction of the two rivers, Shilka, a Russian name, which flows almost 260 miles north-east, when it meets the Argun; the Argun flows north nearly 400 miles before it joins its neighbour. Both streams have a variety of different names nearer their head waters. The ignorance of the people of their own geography has led them to give numerous names to one and the same stream. From this junction of the two rivers, as far as the entrance of the Usuri, the great river for 1,062 miles, or 1,593 versts, forms the boundary between Russia and China. But it was not always so. This river was formerly entirely comprised in Chinese territory, and the northern frontier was then at the Altai mountains, considerably north of this river. The united stream is joined 500 miles lower down beyond Albazin, running in a south-east direction by the Songari. Most of its affluents are on the north bank. There are many islands and banks in the river which seriously interfere with navigation. This well-watered and fertile valley is attracting both Russian and Chinese settlers. It is the great penal settlement for China. The Songari (Sung-hwa-chiang of the Chinese) unites with the Amoor on the right bank, draining the larger part of Manchuria, and doubling the main volume of water. It rises in the Chang-pai-shan, and after running 100 miles we find it 12 feet deep and 900 wide at Kirin. The river Nonni from Tsitsihar joins it near Petune, where the united stream takes the name Kwan-tung (mingled union.) It receives many affluents, and finally joins the Amoor 100 miles west from the Usuri. There is another large river which falls into the Gulf of Liautung at the town of Yingtse—very muddy, like all northern Chinese rivers—and is 650 feet wide at this town. Along the frontier of Corea there is the Yalu-chiang, 300 miles long. The waters of lakes Hurun and Pir are fresh water, and full of fish.

The colonial possessions of China are much larger than China Proper. We do not now speak of Chinese and Independent Tartary as embracing all Central Asia; the former title used to include all the country between Tibet and Siberia and east of the Onion mountains to the Pacific, and the latter all west to the Aral Sea.

Now we speak of Manchuria, Mongolia, Songaria, Turkestan, etc.

Of the four Chinese colonies the first, Manchuria, has three divisions, Shingking with its capital of Moukden; Kirin and Tsitsihar, with their capitals of the same name; second, Mongolia, divided into four provinces, (First) Inner Mongolia, governed by the Colonial Office in Peking; (Second) Outer Mongolia, with its capital at Urga. This province includes four Khanates, each with a Khan under the Kutuktu; (Third) Kokonor, with its chief town of Sining in Kansuh, under a Manchu resident; and (Fourth) and lastly, Uliasutai, including Kobdo and Ulianghai divisions, with the capital of Uliasutai. The third colony is Ili, divided into north and south circuits, the northern called Songaria, with its three divisions of Ili, Kurkarusu, and Tarbagatai. Ili has Kuldja for its capital. The southern circuit, otherwise called Eastern Turkestan, has ten cities, with Yarkand as the chief. Tibet, the fourth of the colonies, is divided into T'sien and How-Tsang, or Anterior and Ulterior Tibet. H'lassa is the capital of the former, ruled by the Dalai-lama and his hierarchy, and overseen by Chinese residents. The latter, with its capital of Shigatsé, is ruled by the Teshu-lama, assisted by a resident from Peking. The united area of the Chinese colonies is about 4,000,000 square miles, i.e., a little more than all Europe. Manchuria has about 400,000, Mongolia from 1,300,000 to 1,500,000, Ili about 1,000,000, and Tibet from 500,000 to 700,000 square miles.

MANCHURIA.

Manchuria is so called from the people Mandjurs or Manchus. Neither the Chinese nor the Manchus themselves employ this term to denote their country. The word is therefore of foreign origin. The Manchus in Peking and over China are known as Chi-jen, bannermen, all belonging to the original eight banners of the Manchus who conquered China. Manchuria lies between 39° and 52° north and 120° and 134° east or about 850 by 500 miles. On the south we have Corea and the Gulf of Chihli, east the Usuri, north the Amoor, west the Argun and Nonni and Songari to the Palisade at Shan-hai-kwan. This western boundary nominally separates the Mongols from the Manchus for some 300 miles. Excepting the late Russian Archimandrite Palladius and the Russian astronomer at Peking, Dr. Fritsche, this region has been little traversed by Europeans. We have no census, the people are nomadic and many of the tribes owe no allegiance to the Emperor.

Different names have been applied to parts of the country at different times, as, e.g., Liautang (east of the river Liau), embracing the part between that river, Corea and the sea of Japan, Tungking (eastern capital, the same characters as applied to Tokio, the capital of Japan and Tungking, the scene of the late war with France), and Kwan-tung (east of the pass). This latter is now the common designation of the country. Manchuria, then, embraces chiefly the valleys between the Usuri and Nonni up to the Amoor on the north and the Liau on the south. We have already referred to the mountain chains, the chief being the long White mountains, which form the watershed between the Songari and Yalu rivers. In the Russian Manchurian territory north of Corea the mountains divide and take the name of *Sih-hih-teh* or Sihota mountains, as already pointed out, on the east, and the Hurkar mountains on the west. Another of the three principal mountain chains, called the Sialkoi mountains, lies on the west of Tsitsihar. This range extends from the bend of the Yellow River in a north-east direction to where the Amoor and Songari rivers meet.

Manchuria for the most part is covered by forests, and abounds in wild animals, whose capture gives employment, clothing, and food to the hunters. Bears, wolves, tigers, panthers, leopards, and foxes are the principal wild animals. It has often been a matter of wonder that the tiger should be found so far north and in such cold regions. Antelopes are frequent all over the north, both in Manchuria and in Mongolia, and are brought to Peking in the winter in a frozen condition, along with scalded and afterwards frozen sheep, fish, and all manner of poultry and game. The capital in winter is thus richly supplied with the produce of these northern regions. The fur-bearing animals are largely hunted for their skins, and Peking is perhaps the largest market in the world for peltry of all sorts sent from these northern regions. Yingtse is the chief mart for tigers' skins. The patellæ of the tiger are in demand in China proper as a remedy for rheumatism of the lower extremities. Bears' paws, also to be had at Yingtse, are considered a great delicacy. The fleshy part of the tail of the deer is likewise so considered by the Emperor, and his troops in Manchuria are required to furnish 2,400 stags annually to the Imperial table. Pheasants and grouse, sold in the Peking market, also abound. The rivers abound in fish, particularly carp, sturgeon, pike, etc. Pearl fishery is said to be remunerative employment. The Government used to collect a revenue in kind from this industry.

In the southern portions of Manchuria, including the greater half of Shingking and the south of Kirin, maize (called jade rice), wheat, barley, millet, and buckwheat, with peas, are largely cultivated. Ginseng, a root held in such high esteem by the Chinese, and which used to be sold for its weight in gold, is a chief product in this country. The most celebrated kinds of this root, which resemble the Chinese character for man, and hence its name, *jen-shen*, are grown in Manchuria. This root is also exported largely from Corea to China, and foreign ginseng, not so much appreciated, from the United States. It is often presented to invalid high officials as a special mark of Imperial favour. It is supposed to have rare strengthening and tonic properties. It once occupied a place in our pharmacopœias, but has long since been expelled as an inert drug. It may be worth reconsideration. Its name and its bestowal as a favour by the Emperor has given it a fictitious value. There is a street in Peking called after this root, where all the merchants deal in it exclusively. Rhubarb also is produced, and both roots are collected by troops sent out in detachments under officers. The officinal rhubarb has lately been found to be obtained from the province of Kunsuh, in North-west China, and is exported to European Russia *via* Kiachta. Domestic animals are also largely reared. Timber abounds, and proves a great source of wealth. In Peking, on the streets opposite every joiner and undertakers' shop, may be seen piles of poles 3 feet in diameter, and 15 to 20 feet long, used for building and in the making of coffins: the latter are invariably prepared beforehand by the better classes, and retained in their houses till required. These poles are brought down the river Liau, or in Manchu, Sira-muren, shipped from Yingtse, and navigated up the Peiho to T'unghow, the port of Peking. Some western travellers who have noticed these rafts on the river at Tien-tsin have described them as imported from America for fuel for the Pekinese!

Manchuria, we have already said, is divided into the three provinces of Shingking, Kirin, and Tsitsihar. Shingking, includes the ancient Liautung. It has Mongolia and Kirin on the north and north-east, the Gulf of Liautung and Corea on the south, and the Chahai country on the west. It has the two departments of Fungtien and Kinchau. There are twelve garrisoned posts at the twelve gates in the Palisade, where taxes are collected on goods and travellers. This department is partly under a civil and partly a

military administration. The rest of the country is entirely under military rule. The late Thomas Taylor Meadows, our Consul at Yingtse, has estimated the population at 12 millions, consisting of Manchus and Chinese. We have no means of judging of the correctness of this or of any estimate, the parts bordering on the two gulfs, and especially the inhabitants of Yingtse, the port, and Newchwang, further up the river, but which name is invariably applied by foreigners to the port, and by which the consular district is known, are chiefly occupied and cultivated by people from the province of Shantung, on the opposite side of the gulfs. These industrious Shantung (east of the mountains) emigrants are ever pushing the aborigines further north towards the Great River, and compelling them to give up hunting and take to farming, if they wish to live on the soil where they were born. And hence along the southern borders of both Manchuria and Mongolia we find a settled or agricultural class of these natives who have given up their nomadic habits. And as in China, so in Manchuria, we find the conquered civilising and developing their conquerors; the latter are losing the knowledge of their own language, and to all intents and purposes are fast becoming Chinese. It is impossible to resist the civilising influences of these peaceful and industrious Chinese. The Manchu name of the capital of Shingking is Mukden, the Chinese name is Fungtien, and on the spot it is usually known as Shinyang. It often, too, takes the name of the province, which means "affluent capital." It is situated on the river Shin, a small tributary of the Liau, and is 500 miles north-east from Peking. The general plan of the city, in its walls, buildings, and streets, is somewhat after that of Peking. The old Imperial Palace stands, as at Peking, in the centre of the inner city. It became the seat of government in 1631, and the successive Manchu emperors on the throne of China during the last two-and-a-half centuries have aimed at preserving, enlarging, and beautifying the home of their ancestors.

Since 1858 Yingtse has been opened to foreign trade. The main, almost the only, trade is in pulse, bean-cake, and oil. The peas are largely grown all over the province—transported in the winter in horse and bullock carts over the frozen roads to Yingtse, where they are crushed by rude native methods. Some foreign machinery has lately been introduced, which at first proved a failure, muscle in China being generally cheaper than steam and iron, partly from prejudice, but chiefly owing to the uncertain

quantity of oil expressed by the foreign machinery. About $\frac{1}{10}$ of the oil is expressed from the peas; bean or rather pea-cake, in the form of large cheeses, is formed, which are transported in foreign bottoms to Swatow and Amoy in the south, as manure for the sugar cane so largely grown there. The pea-oil is used for lighting, lubricating, and cooking purposes. The introduction of some chemically-prepared western manure might easily replace the use of pulse, and throw large tracts of Manchuria free for the production of the cereals for the food of man. Opium is now somewhat largely grown both in Manchuria, along the northern banks of the Amoor, by the exiles from China and others, as also along the upper bend of the Yellow River in Mongolia. The native drug has been gradually driving the Indian from the market. Silk and paper are also prepared for export from Yingtse. At Fung-hwang-ting, near the Yalung River, the Chinese trade with Corea is carried on. The Chinese are not allowed by the Coreans to pass the frontier. On the Manchurian coasts, as on the neighbouring coasts of Chihli, the soil is alluvial, and has been brought down from the lands of Central Asia in the course of ages, and there effloresces a white nitrous salt which renders the land very unfertile. Nitrous lakes are also found. Inland the soil is very fertile, well-cultivated, and populous.

The climate is healthy. The heat of summer ranges from 70° to 90° , and in winter falls to 10° or 20° below zero, showing a less heat but a greater cold than we have at Peking, where we rarely reach zero in winter and average 96° F. during two-and-a-half months of summer. The rivers are frozen from December to the middle of March, or even later. Snow seldom falls to any great amount in Northern China, and hence the Imperial prayers for snow are annually very frequent at Peking. The Pekingese have come to joke at these frequent intercessions for the much-coveted snow, or white flour, as the people sometimes prosaically call it, from the known fact that a copious fall of snow ensures cheap and plentiful wheat, and say that it always blows after the Emperor prays for snow or rain. North-west winds prevail in winter, and usually blow violently for three days continuously, and cause a feeling of intense cold, which keeps the people indoors, and, when obliged to go out, causes them to don furs, and protect the ears and noses, the former with fur caps, the latter by being embedded in their long sleeves. The wind, loaded with sand and frozen particles, pierces the skin like razors or needles. In these regions

the year might thus be divided into six weeks each of spring and autumn, and four or five months each of summer and winter. Hail-storms are not unfrequent, and very dangerous to animals, houses, and grain. During the dust-storms in summer, if succeeded by rain, mud may be seen falling from heaven, discolouring the tiles of the houses and garments and cart coverings of the people. These dust-storms from the north are experienced as far south as Shanghai, and on board ship in the Yellow or Eastern Sea I have seen the sails and deck thickly covered with a yellow powder. The vine, introduced from Western Asia, is cultivated all over the north, and is buried in the winter. The grapes are cheap and delicious, and at Peking are preserved all through the year. The Roman Catholic priests have not found them, however, suitable for the production of wine, and hence have introduced the European grape into their Portuguese cemetery at Peking for the production of their ecclesiastical wine. It is said that a hundred litres of juice of the native grapes produce by distillation only forty of poor spirit. The leaves of an oak are used to rear wild silk-worms, and this forms a considerable branch of industry. The silk-worm, with locusts and some other insects, form part of the animal food of the people. The cocoons of the silk-worm are boiled and the worms are then drawn out with a pin and the hole is sucked until nothing but the pellicle remains. They are relished by the people!

The province of Kirin stretches on the north from Shingking as far as the Amoor and Usuri. The region is mountainous, and thinly inhabited. The people subsist principally by fishing and hunting, and pay tribute of peltry. They are called by the Chinese *U-pi-a-tse*, or fish skin Tartars, or Tatars, as the word ought properly to be written and pronounced. The inhabitants of ancient Beloochistan are said to have clothed themselves in fish skins. The term is employed by the Chinese rather as one of reproach, and seems to have been one of their ancient appellations. The population of this province may not exceed three millions. These people in the future are likely to be amalgamated and lost among Russians coming from the north and Chinese from the south. The town of Kirin has a population of about 50,000, and is situated on the Songari, where the river is a thousand feet wide. Ninguta, on the river Hurka, has wide districts under its sway, where ginseng is collected. At Petuné the persons banished from China for their crimes find a home.

Kirin is richly wooded, and the valleys grow grain; the grain and timber are taken down to the Amoor to supply the Russian settlers. Millet, maize, pulse, indigo, opium, and tobacco are largely grown. The two latter pay well, and the cultivation has of course been largely extended. Manchurian tobacco is famous over all the north, and it was through Manchuria that it was first introduced into North China, having been forbidden by the Manchurian sovereigns immediately before and after they ascended the Dragon throne of China. Tobacco found its way in the early years of the seventeenth century from Manila to Amoy, in the south of China, and to Japan, whence it crossed over to Corea, then to Manchuria and China, thus showing that tobacco is not indigenous to China, nor that it was brought across the Pacific, as some believe. Its old name in the books, tanbacku, indicates its origin. As in other parts of the country, as in Chihli also, oil and samshoo, a coarse, fiery spirit thrice distilled, as the Chinese name implies, from millet, and containing much fusel oil, are extensively manufactured, packed in wicker baskets lined with paper, and transported all over the country in wheel-barrows by men assisted by donkeys. Wild and domestic animals are numerous in Kirin. Hogs and mules furnish the food of the people and the means of transportation, and the wild animals are similar to those found in other parts of Manchuria.

The only remaining province of Manchuria that falls to be briefly noticed is Tsitsihar, or Hei-lung-chiang. This comprises the north-west, extending to about 400 miles from east to west and 500 miles from north to south. The valley of the Nonni, or Noun, occupies the greatest part of it; its area of 200,000 square miles is mostly uninhabited mountainous wilderness. The people live by hunting, fishing, and farming. One of the chief towns of the district, Sagalien-ula, is used as a penal settlement, and has always a body of troops quartered in it. The capital, of the same name as the province, was built in 1692, about the time of the troubles of the Chinese with the Russian marauders and adventurers who were pushing their way to the Amoor in search of the sable. The houses are all heated with brick stove beds, as generally used in northern China. The common crops are like those already mentioned in other districts, tobacco and the poppy bulking very largely. Fish and furs are the chief objects of pursuit. Fairs are held with the Cossacks. The agricultural habits of the Manchus are here strikingly observed as compared with the nomadic and

pastoral life of the Mongols. The Chinese from the Metropolitan province and from Shantung are fast filling up these regions; and this emigration is countenanced by the authorities at Peking as proving the most effective barrier to the incessant inroads of the Cossacks. The country becomes valuable wherever the busy ant-like Chinese settle. A well-known missionary of the United Presbyterian Church has published lately a large work on the Rise and Progress of the Manchus, or, as he writes it, Manjows. Dr. Alexander Williamson, in his "Travels in Northern China," has told us a good deal about this country, but to all intents and purposes it is one of the least known and explored parts of the great continent of Asia. The parts bordering on the gulfs and the port of Yingtse are the only parts that can be said to be thoroughly known. There is in this region a rich territory for any zealous traveller who wishes to advance our knowledge of the geography, geology, and capabilities generally of this great region of East-Central Asia.

MONGOLIA.

Mongolia occupies an enormous tract of Central Asia of a rather undefined character, the country, like its people, being of a changeable character. Its limits, although not strictly defined at all points, may be said to be about 1,700 miles from east to west, and 1,000 in its greatest breadth, with an area of about $1\frac{1}{2}$ millions of square miles, and with a population of about 2 millions. It lies between 35° and 52° N. lat. and 82° and 123° E. long., with five Russian-Siberian Governments on the north, with Manchuria on the east; Chihli and Shansi, two northern Chinese Provinces, and the Hwangho on the south, and on the west by Kobdo and Ili. It is the first in the order of the colonies, i.e., those parts of the empire governed by the Li-fan-yuen at Peking. It forms an immense plateau, some 4,000 feet above sea level, and almost destitute of timber and water, enclosed by the Tibetan and Altai mountains. The desert of Gobi occupies the central part. For its latitude, the climate of the plateau is very cold. This is owing no doubt to its elevation, want of shelter from winds, the vast continent of land, without any great lakes, and the prevailing north-west winds coming from the ice-covered regions of Siberia. In the winter the cold is supportable, except when it blows, because of the cloudless sky, the warm rays of the sun, and the dry atmosphere. The people protect themselves with sheep-skins

and felt-covered tents. Snow and rain do not fall in sufficient quantity to make the soil on the confines of this high land fit for agricultural purposes. The people lead, therefore, a nomadic life, free from tillage, and herd their sheep and other cattle within the limits prescribed to each tribe by the Chinese. Wild birds and animals hold undisputed possession of Gobi. The thermometer in winter sinks below zero 30° or 40°; no month in the year is free from snow or frost. The heat in summer during the day is very great, owing doubtless to the radiation from the sandy soil. *Inner Mongolia* lies between the Great Wall and the desert; *Outer Mongolia* between the desert and the Altai range; Chinghai between Kansuh, Szechuen, and Tibet; and the dependencies of Uliasutai lie north-west of the Kalkas Khanates. This entire region was once called Tartary; and had the great Genghis Khan not called his own tribe the "Celestial People," "Kuhai Mongöl," and all other tribes *Tatars* or tributaries, the designation might have been appropriate enough. Many of the northern Mongols, the Buriats, for example, have become Russian subjects; those on the south, including the three tribes of Kalkas, Chakhars, and Sunnites, comprise the great body of Mongols under subjection to the Manchu dynasty.

Inner Mongolia, or *Nei Mongku* in Chinese, has for its southern boundary the course of the Great Wall, which is popularly supposed to be the boundary between China and Mongolia. This boundary line does not hold good, for large tracts beyond the Wall are now embraced within the Chinese provinces of Chihli, Shansi, and Kansuh. The Kortchin or Ortous are the principal tribes of Inner Mongolia. The Chakhars, another large tribe, are included within Chihli. Shansi includes the pasture lands of the Toumets. Chinese settlers have been making inroads upon these southern Mongols, and driving them from their lands, or compelling them to take to agriculture, and this it was that compelled the Emperor Kanghi to erect into prefectures and districts the southern part of Inner Mongolia like those of China Proper. These constitute now the so-called agricultural Mongols. The Government has reserved certain grazing grounds for the rearing of horses for the Imperial army and service of the Emperor, and also vast hunting grounds at the Palace in Tartary at Jeho (warm river). The Imperial clan has strongly favoured these tribes from the assistance they lent the Imperial troops in conquering China.

Outer Mongolia, or *Wai Mongku*, has four circuits, each ruled

over by a Khan. The tribes from east to west are known as Tsetsen, Tuchetu, Kalkas, and Dsassaktu. They are governed from the capital Urga by two Manchu residents, who direct the material interests of the Mongols, Chinese, and Russians. Urga is in the Tuchétu Khanate, and is the most important and largest place in Mongolia. It is divided into Chinese and Mongol quarters, or Mai-mai-chin (buying and selling mart), and Bogdo Kuren respectively, about three miles apart. Its population is estimated at 30,000, the Chinese inhabitants of the town being forbidden by law to live with their families, probably for a similar reason to the one adduced by Gutzlaff of the town of Kinchau, which he visited in 1832, where, on account of the debauchery of the native sailors, all the females were ordered by the authorities to seclude themselves, in order to put a stop to unlicensed passions. Several of the seaport towns in China, for a similar reason, are almost destitute of respectable families, the commercial and seafaring life with merchants and others from distant parts not being supposed favourable to the morality and virtue of the family life, which in China is one of seclusion and sanctity. What has been well intended, however, has come among the Chinese themselves to be the cause of much immorality. Besides the Chinese in Urga, there are large numbers of lamas, priests of the Tibetan form of Buddhism—they swarm everywhere in Mongolia—who look upon Urga as standing next to H'lassa in point of sanctity, it being the seat of the third person in the Tibetan patriarchate. This is the Kutuktu, the terrestrial impersonation of the Godhead, who never dies, but passes after his apparent decease into the body of a newly-born boy, who is sought for, according to prophetic indications of the Tibetan Dalai-lama, the Pope of the religion. The Chinese Government controls Mongolia through this potentate, who is under his attendant lamas. Enthusiastic devotees of Lamaism send in their contributions to this chief priest, and hence he becomes enormously wealthy; he has a following, it is said, of 150,000 slaves in and about Urga, and lives in the most pretentious palace in Mongolia. Like all other Chinese or Mongol cities, the town of Urga outside the temples is a frightful scene of dirt and pollution, everything being thrown on the streets to be devoured by pigs and mongrel dogs, the public municipal scavengers. The dead in Urga, as elsewhere throughout Mongolia, are not buried but flung on the plain, to be devoured by birds and wild animals, their bones being allowed to bleach in the

winds. These tribes are thoroughly under the power of the lamas; they pay tribute to the Emperor of horses, camels, sheep, and other animals, or their skins, and receive from the Emperor return presents of much more value, so that they are kept in subjection to China by constant bribing. The establishment of the great Lamasary, supported by the Government, where there are some 1,500 lamas, has a similar object. The gentle, merciful, and reverential regard for life of Buddhism has changed these warlike tribes of Mongolia, which once conquered all Asia and overran the eastern half of Europe, and whose armies in the Middle Ages were once a terror to Western nations. The Mongols possess a large literature of Buddhist books, translated into Mongol by Imperial orders. This is the only miserable pabulum supplied to them. Their round tents or *yurts*, made of coarse felt, from camels' wool, are about 10 feet high and 12 feet across. They are secured by ropes to pegs fastened in the ground. Smoke finds egress and light ingress by the roof or the door; there are no windows. The Mongols sit and sleep on felt mats. The fire is in the centre of the tent, upon an iron tripod hearth; one side of the body is being roasted while the other is almost frozen. The position requires to be frequently reversed to ensure equal heating. The felt protects from cold, rain, snow, and heat in a wonderful manner. Muscular rheumatism is very common among them. The people depend upon the produce of their herds and hunting. The Chinese trade with Russia formerly all passed through Mongolia, *via* Kiachta, but since the opening of the Suez Canal much of the trade goes by sea to Odessa. The trade by Kiachta has thus been much reduced. There is still a large trade in brick tea, which is taken to Russia by this channel, and a large portion of the overland tea transported from Hankow to Tientsin by steamer, thence to Tungchow by boat, and afterwards to Kalgan and Kiachta by canal, is sold to the Mongols by the Russians, who are thus free from all Chinese Customs duties in Mongolia, and who, I believe, have resisted the establishment of branches of the Imperial Maritime Customs at their consulates in Mongolia and Ili, which is a palpable injustice to China, and an undesirable inequality between Russians and other trading nations. Some of the tea for overland transport to Siberia, goes from Hankow by way of Shensi, under direction of Russian merchants. By the late Treaty with China, Russia intends to open up a trade route from Hankow through Central Asia, thus securing to her a direct

overland route for tea, silk, and other Chinese produce, through Central Asia to Europe. This route, when opened up and railway communication established, will be a severe blow to our tradal supremacy in the East. Russia may not succeed in reaching the Persian Gulf and Arabian Sea or Indian Ocean through Persia or Afghanistan, and the possession of India, whatever her aim may be, is beyond her grasp; but she is free to work out her destiny towards China Proper by railway communication, either towards the north-west of China and Hankow, or by Kiachta, through Mongolia to Peking. The acquisition of large tracts of Chinese Turkestan would facilitate this movement. Last century her merchants dreamt of connecting Archangel, St. Petersburg, and Moscow with the Pacific, by means of short connections between three or four of the large rivers—Volga, Obi, Yenisei, and Amoor—a plan by no means impracticable. Railway possibilities, and the open waterway from the Mediterranean to the Red Sea have superseded such a system of land and riverine communication. She thus thought to find a nearer way to the wealth of the East Indies. It was Columbus' desire, as we know, to reach the same by westward sailing that led to the discovery of the New World. It was the supposed wealth of China and India that led to the discovery of America; it was the tea of China that led to the Independence of the United States. If Russia should ever be able to carry out such a noble and gigantic railway enterprise as would connect the far East with Europe, and railway transit should be cheapened, a serious blow will be struck at the Suez Canal, and our trade with the far East. It becomes us therefore in time to think of the development of our commercial interests in these countries, and I hail with extreme satisfaction, as a step in the right direction, the recent annexation of Upper Burmah. I hope our Government and merchants will not be slack to make the Chinese see that we are their best friends, as they are ours, in times of peace, and we are each other's best allies in times of war. I have long strongly advocated an offensive and defensive alliance with China and Japan; their possible enemies are ours also. Common interests therefore and common dangers should lead us to court each other's friendship. The western power holding and exercising political influence will be the power that will wield most commercial advantages. If we could amicably, in conjunction with China, arrange the opium question on a more just basis for China, or, still better, enter into negotiations for the gradual stoppage of the

Indian and Chinese cultivation of the poppy—without which there is little hope for the regeneration of China—then I can conceive of a golden future of peace, happiness, and prosperity for the peoples of those Great Eastern Empires who hold the destinies of so many millions of our race in their hands.

But to return. The frontier near Kiachta is marked by a row of granite columns, and a stockade separates Kiachta from Mai-mai-chin. Europe, represented by Russia, and Asia by China, are here brought into sharp distinction.

Much less is known of Western Mongolia than of the other divisions. This division comprises Uliasutai (poplar grove) and its dependencies Kobdo, the Kolkas, and Tourgoutha. The chief officer resides at Uliasutai. Kobdo comprises eleven tribes of Kalkas, who submitted to the Emperor in 1688 to avoid extinction in their war with the Eleuths, by whom they had been defeated. The people pursue the same wandering mode of life. The inhabitants of Kokonor are mostly Mongols, both Buddhist and Mahomedan. This district is not included by either European geographers or Chinese statistical works as in Mongolia. The Chinese call it Ching-hai (azure sea) on their maps, but in their books it is called Hsi-yih, or western limits. It is a district comprising about four degrees of latitude, and eleven of longitude. It has Kansuh on the north, Szechuen on the south-east, Anterior Tibet on the south, and the desert on the west. The Azure Sea, which gives the name to the region, is the largest of several lakes within this region. This lake lies at an altitude of over 10,000 feet, and is over 200 miles in circuit. The water of the lake is salt. Numerous large streams flow into it. All that we know of this region is from Abbé Hue and Col. Prejevalsky. The Tanguts, who occupy the territory, are of Tibetan origin. The Mahomedan Hungaries were nearly all destroyed in the recent rebellion of the north-west. Various tribes of Mongols are also found in the country. The country to the south, stretching as far as Burmah, is exceedingly mountainous. Grain and vegetables are raised on the banks of the rivers and lakes. Alpine hares, wild asses, said by Prejevalsky to be the most remarkable animals of these steppes, wild yaks, vultures, pheasants, antelopes, wolves, mountain sheep, and wild camels are among the denizens of the wilds. Chinese are found also here, and likewise Mahomedans of Turkish origin. Eleuths—the remains of one of the most powerful tribes of Central Asia—Tanguts, and Tourbeths are the

chief tribes. The Tanguts submitted to Kanghi in 1690. They are quite unlike the Mongols and Chinese in dress and appearance. They have a strong growth of beard and whiskers, which, however, they shave. They wear no queue, but shave their heads. The women dress like the men. They herd yaks, which is their sole occupation. Yak tails are largely used as fly flappers by travellers.

I.I.

Ili is the name given by the Chinese to that large tract of country lying north and south of the Celestial mountains, thus including a tract nearly as large as Mongolia, and quite as unfruitful. It extends from 36 degrees to 49 degrees north latitude and 71 degrees to 96 degrees east longitude, and its area is not far short of one million square miles, of which Songaria occupies about one-third. The northern circuit, 900 by 300 miles, is commonly called Songaria, from the Songares or Eleuths who ruled it until lately, and the southern, 1,250 by 300 to 500 miles, as Little Bokhara or Eastern Turkestan. Ili has the Altai mountains on the north, which separate it from the Kirghis, in Chinese the *Chi-li-chi-tse*; north-east, the Irtish River and Outer Mongolia; east and south-east, Kansuh; south, the desert and the Kwen-lun; west, Belurtag, dividing it from Bodakshan and Russian territory. The treaty entered into between China and Russia in 1881 defines the boundaries in Ili between the two countries. The great elevation, the isolation as to its water-courses—there being many closed water basins between the Altai and Tien-shan—and the character of the vegetation are the most remarkable characteristics of Songaria. The policy pursued in all these regions by the Chinese Government has been to send criminals to till the soil so as to induce the tribes to settle. They also send large bodies of troops with their families. The nomads thus find a market for their cattle and other products, and are induced to settle down. This policy has succeeded fairly well. The convicts are obliged to work and assist the troops. The Chinese, themselves originally a wandering tribe, are thus seen extending the capabilities of their great empire, and teaching—partly by force, by bribes, and by example—the nomads the advantages of a settled life. The country provides the usual cereals, with tobacco, cotton, melons, and some fruits. Horses, camels, cattle, and sheep are plentiful. The Eleuths, Tourgouths (those wonderful people, whose return from the

Volga to the old sway of China in 1772 is described by De Quincey, and Staunton has given us a translation of the mission of Tulishen in 1712 to these Turgouths on the Volga), the remnants of the Songares, together with Mongols, Manchus, and Chinese troops, settlers, and criminals, make up the population. Ili, the name of the capital of the northern circuit, otherwise Kuldja, is a town which formerly contained about 50,000 inhabitants, and carries on a considerable trade through the Kansuh towns with China. It is Turkish in its origin. The present population does not exceed perhaps 20,000. The Taranchis are about one-half, then come the Dungaries, and, lastly, the Chinese and Manchus. There is abundance of coal, metals, and fruits; these are the sources of its prosperity. Great destruction of life and property took place during the rebellion. The country was first conquered by the Emperor Kien-lung in 1772. There are now some 60,000 troops stationed at all the posts in this region; and the total population of Songaria is under two millions.

The southern circuit contains eight Mohammedan cities, and was called by Kien-lung the "New Frontier," or *Sin-kiang*. It is less fertile than the northern, and consists chiefly of mountainous barren wastes. It has the Kwen-lun range and the desert on the south, separating it from Tibet; on the south-west Cashmere; on the west it is separated by the Belurtag from Badakshan and Kokand. Some of the passes over the mountains are from 12,000 to 16,000 feet high. The river Tarim runs through this region, and, after a course of about 1,200 miles, flows into Lake Lob. Prejevalsky's researches into these regions are interesting, in a geographical point of view; and a work on "Mediæval History and Geography of Central Asia," by my friend and former colleague, Dr. Bretschneider, of which I had hoped to give an abstract, in place of this meagre and hurriedly written paper, the leading facts of which and some of the language is collated from Dr. Williams' standard work, "The Middle Kingdom," will shortly be published by the Messrs. Trübner in English, and will throw a flood of light upon many obscure questions relating to Central Asia. The light thrown upon the question by the Russian advance and explorations in these little-known regions will also be taken advantage of. We shall be put in possession of all the information possessed by the Chinese and Russians on this question; and from the translation of much of it which I have made from the German, and the correction of the proofs which have passed under my eye, I can

vouch for the interest and importance of the subject. Prejevalsky, whose acquaintance I had the honour of making at Peking, previous to his journey through Northern China into Mongolia, has mapped out the true position of Lobnor, which he says is elliptical, 90 to 100 versts long and 20 wide, and 2,200 feet above the sea. Enormous flocks of birds going north or south make Lobnor their halting-place. The desert here is poor and desolate, and a spur of the Kwen-lun here rises straight up to 14,000 feet! There are wild camels in its ravines. Besides the grains and fruits of Southern Europe—the sesamum taking the place of the olive oil—all sorts of domestic animals abound, and the camel and yak are hunted and raised for food, service, and clothing. Wild animals abound. The district is rich in minerals. Sal-ammoniac, salt-petre, sulphur, and asbestos are obtained from the volcanic region on the east of Tien-shan. The Chinese movable fire stoves are all made from this asbestos. The highly valued jade, or *ü* in Chinese, a species of nephrite, is obtained in this circuit. This jade is most highly prized in China for ornaments of all sorts, and tobacco-pipe mouthpieces. The eight cities from east to west are the following:—Harashar, Kuché, Ushi, Aksu, Khoten, Yarkand, Kashgar, and Yangi-hissar. The Mohammedan populations of these regions are always restive. They lack the elements of substantial progress and national growth, both under their own and the Kitai rulers, for so they term the Chinese. The Russians call the Chinese by a similar name, derived from the race of Ki-ta, which held sway in the 10th century, from which we have our word Cathay, a word of Persian origin, but which is quite unknown to the people it is intended to designate. In these regions the Chinese do not prove hard masters, and bring trade and wealth the longer they remain. The resources of the country are insufficient to meet the expenses of the military establishment and the presents made to the begs; the deficit is, therefore, supplied from China.

I shall not attempt the topography and trade of these eight cities, however interesting it might prove. Of Kashgar I will merely say that the great reason for the Chinese persevering in retaining so expensive, so turbulent, and so distant a frontier province, is its natural mineral productions, particularly the esteemed jade, but gold, silver, copper, coal, iron, sulphur, alum, sal-ammonia, and zinc are all found, and give abundant employment to Chinese settlers. Moving sand-hills in some sections of the country have prevented the people from building villages, for

not unfrequently such are overwhelmed. Kashgar about the year 1000 was the capital of the Oigurs for a long time (the Chinese word Hwei-hwei, for Mohammedans, is said to be derived from the first syllable of this word) and its ruler forced the people to accept Islamism. Under Genghis the city became still more important, but it was razed to the ground when Abubahr Miza took Yarkand. Under the Chinese it has become one of the richest marts in Central Asia, and its position determines its continued future importance. Its manufactures in jade, gold, silk, cotton, gold and silver cloths, and carpets are well known. Yarkand is the political capital of this division. It is one of the ancient cities of Tartary. The working of jade in all its colours of yellow, white, black, and reddish for bangles, earrings, etc., gives thousands of families employment. All these articles are carried to China, where alone they are highly esteemed. In the destruction ensuing on long struggles for supremacy, which has overthrown the sway of one ruler after another, and under which all these peaceful industries have disappeared, one learns, as remarked by Dr. Williams, the explanation of the barbarism which has succeeded the downfall of mighty empires all over Western Asia. It was in Khoten that the great Russian traveller in 1879 discovered a new variety of wild horse, a specimen of which has been stuffed and exhibited in St. Petersburg, a form intermediate between the domestic horse and wild ass. In Mongolia religion is employed to aid the State; in South Ili it is strictly military. In North Ili, where they are swayed by religious rites, the government is easier and more effective for the distant court of Peking than it would otherwise be. Some one has suggested that our Irish troubles might be settled most effectively by endowing the Roman Catholic Church, and therefore compelling it to aid the State. If so, this would after all prove the cheapest and easiest way of pacifying this troublesome island. State-paid priests of the Roman Catholic religion may be taught to keep their otherwise turbulent flocks in order. There is a great difference in religion, race, and language in the south circuit, the inhabitants being Mohammedan. The late rebellion was one of dominion not one of religion, and their co-religionists in China and Peking, although so numerous—calculated at 10 millions north of the Yangtse and 200,000 in Peking alone—were unmolested by the Government during that long and severe struggle. The Mohammedans of South Ili pay a monthly capitation tax of about a florin and tithes on the produce.

There are no transit duties as in China, but custom-houses are established at the frontier trading towns. The history and struggles of this region from the earliest times provides an interesting chapter of history. To this we shall not refer. It has been lost to, and won by, the Chinese several times. The oppressions of the Chinese officials, resorting as they do to illegal means to reimburse their outlays, frequently goad the Mohammedans to rise against the Chinese, but the Imperial policy is conciliatory and the people's complaints are in general listened to. The begs and princes resort yearly to Peking to pay tribute, and this gives them an opportunity of stating their grievances, and prevents them also from forming cabals among themselves. In 1871 the Russians took possession of nearly all the north circuit during an insurrection of the Dungans against the Chinese. The Russians promised to restore the territory to the Chinese when they could hold it and preserve order. The Russians never believed they would be called upon to deliver it up. But they forgot the persistency of the Chinese never to give up what they have once possessed. Ten years after, when the Chinese had suppressed the rebellion, Ili was grudgingly delivered up, an indemnity being paid by China for the expense of the Russian administration. The history of the march of old Tso-chung-tang's agricultural army in conquering the territory of the north-west, which for a dozen years had rejected the Chinese authority, and whose people had risen in rebellion during the great Taiping rebellion in China, and when the Imperial authority was reduced to the lowest ebb, would, if thoroughly known, constitute one of the most remarkable military achievements in the annals of any modern country. The Attalik Ghazi, or "Champion Father," as Yakub Beg was called, died, or was murdered, in May, 1877. Kashgar fell in December of the same year, which practically completed the re-conquest of the region. The Chinese in December, 1878, sent my friend Chung How, a high official, to Russia upon a mission relating to the restoration of Kuldja. The affair is too fresh in all our recollections to need minute description. The Livadia Treaty was drawn up, by which a portion of Ili was yielded to China—Russia retaining all the fruitful and strategic parts. Moreover, China was to pay an indemnity of five million of rubles for the cost of occupation. Various important tradal concessions were made to Russia, such as the opening up of a trade route from Hankow to Kuldja and Siberia, the opening to Russian caravans of thirty-six

frontier stations, the modification of the Kashgarian frontier, the arming of Russian merchants (!), and the navigation of the Songari river. The Russian Court was too astute, the Chinese Ambassador was too gentle, and had no knowledge of the region. Upon returning to Peking in January, 1880, he was thrown into the Hsingpu—the Board of Punishment, one of the six Administrative Boards of the empire—denuded of all his offices, and finally sentenced to be executed. He had signed away territory and promised indemnity without special authorisation. The foreign Ministers remonstrated on the monstrous barbarity of the sentence; Russia refused to receive a second Ambassador (my friend the Marquis Tsēng) unless Chung How was unconditionally pardoned. Russia felt his punishment as a terrible slap in the face to her eager diplomacy. China prepared for war—the passions of the Chinese in the north, and, indeed, all over the empire, were aroused against Russia. Colonel Gordon (Chinese Gordon) visited Peking, and enjoined peace, pointing out the folly of a war with Russia. China respected Gordon, and his counsels carried great weight. War was averted. Chung How was reprieved, and set free. In May, 1881, Tsēng succeeded in making an agreement, by which the Czar returned the larger part of Ili, retaining a strip say some, about one-fourth say others, on its western edge, for purposes of colonisation, or retreat for those inhabitants of Ili who preferred to remain under Russian rule! The Chinese agreed to pay nine million rubles for Russian administration, merchant losses, and sufferings. To Oriental diplomacy this looked less repugnant than being called upon to pay five millions in acknowledgment of getting back their borrowed property. This same policy was pursued in paying the Japanese indemnity in the Formosa trouble; and even France might have secured a handsome indemnity for the trouble in Tung-king had the claim been as adroitly managed; but the Chinese refused to pay so many millions for what was their own. Other clauses of the Russian Treaty were altered, particularly that relating to the Songari river. It was ratified on August 18th, 1881. The strategic part is still in Russian hands, and troubles are likely to occur here in the future, both parties being anxious to get the Kirghis, Dungaris, and Usbecks of the region to settle permanently on their side of the boundary. Russian agents have lately been accused of fomenting troubles in this region, with a view to the overthrow of the Chinese rule. China is beginning to learn that it is useless to

attempt to drive out the hated foreigner ; she saved Corea, by opening the "Hermit" and "Forbidden" land to western trade, from the clutches of the great northern and ever south-advancing Power; and she feels now that if she is to preserve her own integrity, and beat back aggression, it is by courting trade and the friendship of disinterested allies, opening up unreservedly her empire, and adopting western modes of civilisation.

TIBET.

The third great colonial division of China is Tibet, less known and hardly less extensive than Ili. Mountains hem it in on all sides. It is the most southern of the three great table-lands of Central Asia. The name by which the country is known to us is unknown by the people. It seems a corruption of the Mongol Tu-po, the country of the Tu, a race which overran it in the sixth century. The people themselves call their country Bod, probably from some connection with Buddha, the Hindu word being *Bodh*, or Truth. The Chinese name is *Tsang*. It has Kokonor on the north-east, Szechuen and Yünnan on the east, Assam and Nepaul on the south, Cashmere on the west, and the Kwen-lun on the north. From east to west it may be 1,500 miles. Beltistan, Little Tibet, and Ladak, although included in Chinese maps, hardly owe any subjection to Peking. The highest plains of Tibet have a mean elevation of nearly 12,000 feet. The snow line on the north of Himalaya is at 16,630 feet, and on the south slope at 12,982 feet. Tibet encloses the fountain heads of all the large rivers of Southern and Eastern Asia. The Brahmaputra, rising in Tibet, is the largest and longest river in Southern Asia. The central part of Tibet is a country of lakes. The largest, Teng-kiri-nor, is over 100 miles long by 30 broad. The climate of the country is remarkable for its purity and excessive dryness. The mountains are covered with snow ; the valleys are hot. Everything gets quite dry ; and it is said meat exposed to the open air gets so dry that it can be powdered like bread. The Tibetans, like the Mongols, make a tea into which they place butter and salt, and add barley meal, or, as in the case of the Mongols, small millet, and serve it in small wooden bowls. In Mongolia they invariably wipe their dishes with a horse's tail. Sheep and goats are largely reared. There are plenty of domestic animals, and also wild animals. The yak is the chief animal of the country, and is very hardy ; it is said to be a cross-breed from the yak bull and native

cow. There is little agriculture in Tibet. The most of their medicines come from China. The mineral productions are exceedingly rich. There is a great want of fuel with which to smelt the ore. Many precious stones are found, which are taken to China.

As already said, the Chinese division of the country is into Anterior and Ulterior. In the former are eight cantons. H'lassa is the capital. The name signifies "God's ground." It is famous for the convents near it, composing the ecclesiastical establishment of the Dalai, or Ocean lama, whose residence is at "Red Town," on Mount Putala. The principal building is 367 feet high. This city is the head-quarters of Buddhism and the hierarchy of the lamas. The Dalai lama and Kutuktu control all Tibet and Mongolia. This city lies in a fertile plain, about 12,000 feet high, 12 miles wide, and 125 from north to south. The town is supposed to have 24,000 inhabitants.

The capital of Ulterior Tibet is Shigatsè, 126 miles west of H'lassa, and under its control. Here the Teshu lama resides. This division of Tibet has six cantons, besides the territory under the jurisdiction of the chief town. The Tibetans are superior in mechanical art to the Mongols, but inferior to the Chinese. Their dress in general partakes of the character of the Mongols. They dress in furs, and seem to emulate the animals they derive them from in weight and warmth. The dress of the sexes varies slightly in shape. Yellow and red are the predominant colours. All persons wear long boots of hide. The women wear jewels, and adorn their hair with pearls, corals, and turquoises. Girls braid their hair in three tresses, married women in two. In all this they resemble closely the Mongols, both men and women, who are seen in large numbers at Peking in winter.

The two religious sects are distinguished by yellow and red caps; the latter are few, and allow the lamas to marry, but in other respects are not very different. In no country are so many people devoted to religious service as in Tibet, nor one where the lay people pay such deference to the clergy. Mutton, barley, and tea constitute the staple articles. Substitute millet for barley, and the same holds true of the Mongols. In making a present it is necessary to send a white silk scarf with it, the size and texture being proportioned to the rank and condition of the parties. I possess a goodly number of these silk scarfs, received from Mongol princes and others. Woven upon each end of the scarf you usually find the phrase, "Om, mani, padmi hom" (O! the jewel in the

Lotus. Amen)—a single utterance of which is sufficient of itself to purchase an inestimable salvation! Raising the cap in reverential salutations, exposure of the dead to be devoured by wild animals, burning of the lamas and the collecting of their ashes into urns, all resemble similar customs among the Mongols. Polyandry prevails; the usage is, however, not universal. One of the husbands may leave the roof and marry another woman. The object is to keep the property intact among the members.

The manufactures of Tibet are woollens, cloth, goat-hair shawls, musk, paper, metals, and jewellery, gold and silver ware. These industries, however, languish from so many men being drawn into monasteries, and the remainder require to devote their attention to tillage. They export to China gold dust, precious stones, bezoars, highly prized as medicines by the Chinese, *asafœtida*, musk, woollens, and skins, and receive in return silks, tea, china-ware, tobacco, musical instruments, and metals. Spirit drinking is common, and yet the people, like the Chinese and Mongols, are not a drunken race. The poppy cannot be well cultivated among the mountains, and hence the people are not so much addicted to this curse as those of Assam or Chinese districts, where the poppy flourishes, and where it is said from 60 to 90 per cent. of the entire population are addicted to the vice. Education is confined to the priesthood. The language is alphabetical, and reads from left to right. They use one character for books and a different for writing, like our own Roman and running hand. The form of the characters shows their Sanscrit origin. There are 30 consonants in the alphabet. The literature, like the Mongol, is almost wholly theological. They adopt the Chinese divisions of time, numeration, chronology, and weights. The Tibetans, from the similarity of their religion, make them much easier under the Chinese yoke than the Mohammedan. The Tibetan or Mongol or Northern form of Buddhism is also called Shamanism, from a Hindu word meaning the overcoming of the passions. The sect is often called *hwang-chiau*, from the yellow robes worn by the priests.

At Peking is a well-known Buddhist temple called *Hwang-sz*, or yellow temple, containing a remarkable monument, erected by the Emperor Kien-lung. In 1779 the Teshu lama started for Peking, with an escort of 1,500 men. He was met by the Emperor, and conducted to Peking with great honour, and lodged in this temple for several months. On 12th November, 1780, he

died here of smallpox, which is said by the Mongols to be a Chinese disease, and this cenotaph of white marble was erected to his memory. His body was enclosed in a gold coffin, and sent to the Dalai lama in 1781. On this monument we have carved scenes in the prelate's life, one of which represents a lion rubbing his eyes with his paw, as the tears fall for grief at the lama's death. Lord Elgin was quartered here in 1860.

In relation to Tibet, so long closed against all foreigners, it is important to note that, by the separate Article of the Chefoo Convention, it is said—"H.M. Government having it in contemplation to send a mission of exploration next year, by way of Peking, through Kansuh and Kokonor, or by way of Szechuen, to Tibet, and thence to India, the Tsung-li-yamen, having due regard to the circumstances, will, when the time arrives, issue the necessary passports, and will address letters to the high provincial authorities and to the Resident in Tibet. If the mission should not be sent by these routes, but should be proceeding across the Indian frontier to Tibet, the Tsung-li-yamen, on receipt of a communication to the above effect from the British Minister, will write to the Chinese Resident in Tibet, and the Resident, with due regard to the circumstances, will send officers to take due care of the mission, and passports for the mission will be issued by the Tsung-li-yamen, that its passage be not obstructed."

The new opium treaty has been entered into,* and one of the first fruits is the carrying out of this arrangement. The Hon. Mr. Macaulay has just been to Peking, and obtained the promise of the necessary protection and passports for a mission to Tibet, from either the Chinese or Indian side, of which we shall certainly not be slow to take advantage, so that we shall hear ere long of the opening up to the world of perhaps the least-known country on the globe.

A discussion of China's tributary nations would have opened up a large and interesting field, and would have led us in another direction; in fact, from a Chinese point of view, would have embraced all the nations of the earth from China to Peru, who are supposed to look for light and leading to Peking. In the narrower view of the subject we should require to have sketched the Bur-

* Since the above was written, we learn by telegram from Peking that the German Minister has notified the Tsung-li-yamen, that Germany will veto the ratification of the Opium Convention, unless she receives substantial compensation.

mese, Siamese, Cochin-Chinese, Nepaulese, Coreans, and Loochooans, which are nominally vassals of the "Son of Heaven," whose names remain on the roll of fiefs, and who at stated intervals repair to Peking, or send tribute there. There is the tribute quarter at Peking, where their Embassies are quartered. The foreign Legations occupy the same quarter. The Siamese and Cochin-Chinese, since 1860, have ceased to send tribute; the Loochooans have been absorbed by Japan, and are not likely again to revisit their Legation at Peking in any capacity; while the others derive advantage from the facilities of traffic, which they are unwilling to give up. The Chinese Government undertakes to pay all expenses from the moment of crossing the Chinese frontier, both in coming and going. These Embassies are allowed to bring numerous articles of trade along with their tribute, upon which no duties are levied. On returning they take back to their own country products of, or foreign goods imported into, China. This form of tribute is a pleasing way of doing a large and lucrative trade, and hence the surrounding nations are willing to continue their dependency upon China. A late Nepaulese Embassy brought an enormous quantity of Indian opium, which, admitted duty free, they sold to great advantage all along their long route through China, and reached Peking with such quantities that the suspicions of the Customs authorities were aroused, and they were mulcted in a huge sum. This, however, was returned, it being opposed to the favour bestowed upon tributaries by the Emperor. On returning they were provided with pack-horses, and loaded with presents, and the officials *en route* were ordered to forward them. Each winter there is a similar Corean Embassy, amounting to 200 individuals, who are treated in an identical manner. They drive a great trade at the capital in ginseng, fans, combs, strong Corean paper, used in the north of China so plentifully for window glazing, etc.; and in returning carry immense quantities of foreign cotton into their country duty free, which they obtain at Tien-tsin, and the transit expenses, all borne by the great Emperor. Burmah has very recently ceased to be an appendage to the "Dragon Throne," and now is connected with the sway of the Empress of India. This annexation is a measure which ought to meet with the entire approval of the people of these realms, who have the political and commercial interests of India and this country at heart, and who also feel that it is our duty to introduce our Christianity and

civilisation, and to throw the ægis of our protection over down-trodden nationalities who are subject to those barbarities and inhumanities of their own rulers which "make countless millions mourn," or who are exposed to the intrigues of other nations, which could bring, in the long run, nothing but disaster. The ease with which the country has been taken by, or rather delivered up to us, and the satisfaction of the common people with their new lot, are the best arguments that can up to the present be adduced in favour of the change. The future will speedily introduce them to peace, prosperity, and happiness, like their countrymen and co-religionists of Lower Burmah, from whom they have been so long separated, and a highway thus secured to South-western China.

As the question of the annexation of Burmah is in some quarters condemned, and a discussion of the subject is likely to arise in Parliament, we shall be excused for referring so politically to the subject, and further adding and emphasizing the statement, that we cannot afford to stand on ceremony with a potentate of Thebaw's kind, at the expense of jeopardising our legitimate interests and those also of his own country. No petty, mis-governed, and disorganised state, of the description of Upper Burmah, can be permitted permanently to form an almost insurmountable barrier between ourselves and China, whose mutual interests in Asia demand that they be friendly neighbours. Political laws and commercial exigencies nowadays require that all considerations must give way to the greatest good of the greatest number. It is in this case the law of the survival of the fittest. The present condition and future prospects of British Burmah form, too, one of the most incontestable arguments for placing the remainder of the ancient kingdom of Ava under similar conditions. If this step had not been taken now, in addition to the intrigues of our Gallic neighbours, who have been trying to found an Asiatic empire similar to our India, and thus reproducing in Asia a geographical existence similar to that subsisting between us in Europe, with, however, certain very great differences, we should have had the opening up of Tung-king by France, and the possession of commercial advantages, *via* the Red River, with Kwang-si, Yün-nan, and South-western China generally, which threatened to drive us, the pioneers in China, from our legitimate share of the commerce of these regions. In this respect the Burmah annexation was necessary to effectually neutralise the

disastrous effects of French supremacy in that quarter, and to confirm our relations with Siam and the Shan States. Such an understanding between the peoples of China and India, or, rather, of their respective governments, for the peoples of both countries are profoundly ignorant of the great questions involved in the welding of political and commercial bonds between the two countries, comprising a population one-third of the globe, is the grandest conception of modern times, and throws into the shade the triple Imperial alliance of the west. The strictly defensive character, too, of such an alliance, renders it a consummation highly desirable in every point of view.

Our frontiers will now march with Yün-nan. We are therefore the first European power that has come into direct land connection with China Proper. France as yet holds too precarious a grip over Tung-king to permit us to take her present condition there into account in this connection. China has nothing to fear from our proximity to her in the south-west. So far as is known, she has offered no objection to the annexation, showing thus a marked contrast, which it is well to note, to her conduct towards the power that has wrested Annam from her. China has lost territory all round that for centuries owned her suzerainty. The southern tributary States may now be said to be all lost to her, not through any fault of either the dominant or vassal power, but by reason of the colonial extension of western powers. Corea in her late treaties with western nations has had her independence acknowledged. When it suits China, however, she is prepared to urge her old claim, and the Coreans will be ready to obey. The "Hermit" or "Forbidden" land still sends her tribute regularly, and when her kings are crowned China must be represented. The Russians during the last 300 years have often attempted to advance to the Amoor to gain the rich sables for which the region is famous. As early as 1567 two Cossacks reached Peking, but for want of presents did not see the Ming Emperor. Again, in 1619, Evashko Pettlin and a companion crossed the desert from Tomsk, reached Peking, but for want of presents, could not see the dragon's face, and were sent back with a letter which, it is said, all the learning at Tobolsk and Moscow could not decipher. Again, in 1653, the Czar Alexis sent his envoy, Baikoff, who was dismissed from Peking because he would not perform the nine prostrations before the Emperor. Lucrative trade was carried on by caravans every three years from Russia. We read of such

caravans or trading embassies as early as in 1658, 1672, and 1677, which were more or less regularly continued for almost another century, until the frontier trade was finally established at Kiachta. During all this time quarrels were frequent between the Chinese and the Russians on the Amoor, especially at a place called Albazin, in Chinese Yaksa. Fortune favoured both sides at times. The Chinese Emperor, Kanghi, was determined to drive the Russians from the Amoor, and finally Albazin fell, and the Russians were taken prisoners to Peking, treated well, included in one of the banners, Russian priests were invited from Russia to teach them, Russian was taught, the school became the germ of the present College of Languages, two Buddhist temples were given them, and thus it came that the Greek church got established at Peking, and the Russians their first settlement in China. At the treaty of Nipchu, in 1689, the first treaty ever agreed to by the Peking Court, the frontiers of the two countries were defined. The Russians were obliged to retire from Albazin, the Amoor, and Manchuria, where they had held their own for 38 years, and the Daourian or Altai mountains were defined as the frontier, and certain articles regarding trade were obtained by Russia. Various other treaties followed. From that time on the Russians have ever been encroaching, until they became masters of the north or left bank of the Amoor, and in 1860, as the price of their neutrality, obtained that important slice of Manchuria south of the Amoor, east of the Usuri, and north of Corea, which, to a maritime power, is her most vulnerable part. China has thus lost heavily of territory in the north during the last two centuries, caused by the advance southward, eastward, and seaward of the great Northern Power.*

China is almost as much interested in Afghanistan as we are; and Corea, Ili, the Amoor, and Manchuria, if we understood our own interests properly, should be subjects of anxiety to us. The arena of conflict by which Asia will be parcelled out among the three great Asiatic Powers will most probably be decided on Chinese soil in Central Asia. These three great Powers are those destined to guide the destinies of the Old World. They are already advancing, and preparing, as it were, for the conflict. Russia and China never can be allies—the former has too much to

* The writer has a work in preparation on "Russian Relations, Political, Commercial, and Ecclesiastical, with China, from the earliest times down to 1860."

win, the latter too much to lose. Britain has everything to gain, politically and commercially, in Asia, Europe, and Northern Africa by a strong alliance, offensive and defensive, with China. Our interests and dangers are identical; hence the importance of an alliance for mutual support against the aggressive movements of a common foe. Our interests being common, our duties and obligations should be reciprocal. China is our best trading ally in times of peace and our best fighting ally in times of war, and these two objects to us are worth more than anything else we could possibly aim at. Japan must join these two. Her permanent interests and continued independence indicate no other alliance as advisable. The first step in the onward march is the acquisition by us of Burmah. France occupies as yet a very unstable position in Annam, and but for her solicitude for her good fame, which precludes her from the idea of abandoning her recent acquisitions, she would have withdrawn from these Eastern colonising schemes. Successful French colonial policy requires a degree of perseverance and tenacity in which the people are sadly deficient. Her past experience in the peninsula will keep her from meddling with those intermediate buffer States which separate us from France. But in the north Russia has her eyes on Kashgar and other Central Asian dominions of China, and Corea has narrowly escaped passing under her yoke. That peninsula must be safeguarded, in our interests as well as in her own and those of her two ethnologically allied neighbours. Our maritime position in the far East, our trade with China and Japan, if not our colonial possessions in the extreme Orient, are all at stake, and depend very vitally upon the independence of Corea. Its acquisition by Russia, by which she would acquire open harbours in winter, would be a constant menace to all three countries. Fortunately we have acquired, reported to be by a small concession to China on the port opium duty, a naval station (Port Hamilton) at the entrance of the Japanese Sea, by means of which we shall prevent the descent from the north of hostile ships in that quarter, and can therefore look, perhaps, with less anxiety upon the possession of Corea by a foreign power. Her safety and independence may, however, be considered as now secured and guaranteed. China and Japan are both well aware that they have nothing to fear from Great Britain. Our policy is conservative and peaceful. Many years ago the Japanese ceded the southern part of the great, important, and rich island of Sagalien to Russia, the 50th parallel, which cut it in two,

having been the recognised boundary between the possessions of the two Powers. Japan needs this island for the industry of her surplus population. The advent of Russia in these parts is of very recent date. The island naturally forms one of the Japanese group, and lies at no great distance from the nearest of their islands. A *quid pro quo* for Sagalien were the utterly unimportant Kurile Isles ; and adjoining Sagalien and the Japanese Sea, on the mainland, is the large tract of territory already referred to, now denominated Russian Manchuria, the home of the Manchu conquerors of China and of the present reigning family. Part of Ili, and that the strategic part, has been retained by Russia. Troubles ever and anon break out in these distant regions, fomented, it is said, by Russian agents. China is not satisfied to have been robbed of territory both east and west by Russia, and would gladly avail herself of favourable conditions for their restoration. She, too, needs colonising fields. At the same time, we must do Russia the justice to say that her rule in Central Asia has brought many blessings to the people, not the least being settled government, security and freedom, markets for their produce, and a currency in exchange, instead of, as formerly in most cases, produce in kind or brick tea. The Buriats, now included with Russia, are prosperous and contented Mongols. If China is therefore to retain these nomads, she has much to learn from Russia. Her great weakness is the corruption of her officials, and this leads to rebellion.

The importance of an alliance with China against Russian aggression in Asia, in the interests of both China and Great Britain, cannot be over-estimated. Both nations have observed the steady process of encroachment pursued by Russian generals and diplomatists. The Russians have hitherto looked upon this tendency as their destiny, and therefore beyond their control. The "scientific exploring expeditions" have been the forerunners of the appropriation of hundreds of square miles of territory. Frequent occasions have occurred on the north and north-west of trespassing upon Chinese territory ; the shifting, it is reported, of the boundary stones ; and in many cases, it is said, the mandarins have been afraid to report the matter to Peking. Both nations are now adopting similar measures, the one to extend the frontier, and the other to prevent further losses, by settling families of their respective countries in these regions. The Chinese military colonies on the Amoor will prove a formidable obstacle to con-

tinued Russian annexation. The history of Russian encroachment in Chinese territory has been similar to that on the small Khanates in Central Asia.

Our last war with China gave the astute Ignatief the opportunity of wringing from the enfeebled hands of Peking the concessions of that large and rich stripe of Mauchuria which has made Russia a power on the Pacific Ocean, and brought her into contact with Corea, which was destined to fall into her hands on the occasion of the first trouble with China. During the French embroglio, a German gentleman, at the head of the Corean Customs, had actually entered into a treaty with Russia, by which Corea would have been handed over to that power. This scheme was rendered abortive, and the agent superseded.

The suppression of the Tai-ping rebellion, the crushing of those of the Mohammedans in the south-west and north-west, and the recent encounter with French-African troops, have taught the Chinese confidence in themselves. During the late war they had the largest and best drilled and foreign accoutered part of their huge army stationed in the north, partly to protect the capital if a descent should be attempted by France on the Pei-ho, but also in case of a Russian one on Corea or in the north.

China is learning a lesson from us; and just as we have been opposing the forward advance of Russia southward in Afghanistan, so China has been considering the propriety of similar opposition to a like advance on the Amoor, and has been pressing the question of delimitation of the frontier boundaries, which, it need not be said, have been met hitherto, as in Afghanistan, by delays and excuses. The Chinese diplomacy, however, is so far unlike ours, that these Orientals are not accustomed to allow demands to "lapse" without a strong effort to gain their case. The military and naval activity manifested by China at the present day, and the inauguration of railways, is more with this object in view than the development of the country, and must prove highly inconvenient to Russian statesmen. The want of a railway to the Amoor is a great drawback to Russia, and in the event of a war with us every soldier would have to be transported across the steppes of Asia before she could come to the relief of her garrisons on the Amoor and in Russian Manchuria. China is much nearer her base of operations, although with her the distances are also very great; but the plan pursued by her army in the north-west rebellion, of sowing grain and moving slowly, renders distance of less value.

As Russia took advantage of China's troubles in her war with us, so China was inclined to imitate that policy, and during the Russo-Afghan dispute was prepared to solve some of her outstanding difficulties with the northern power, thus pointing out to us the expediency of a firm alliance. We do not know how far China's possible action influenced Russia in the settlement of the Afghan question.

The peace-at-any-price party in our country has not the best interests of either our own land or that of the world at heart in the policy it pursues. Its position is utterly untenable for a power like Great Britain. This country depends for its welfare so largely, almost exclusively, upon trade with foreign countries and our colonies, and it is perfectly clear that the trade and commerce of this country can never expand, or be in a satisfactory condition, unless our foreign policy is such as is calculated adequately to protect and develop our trade. The vital commercial interest of our country should be the keystone of our policy. China is undoubtedly the country to which we must look for a revival of our trade, and as an important factor in the maintenance of the peace of the world.

One great European Power is making a stupendous bid at the present time for commercial supremacy in the far East, and a vigorous commercial campaign against us in the China Seas in particular. Other countries, too, are energetically bidding for a share in the expected development of the material resources of China. Our statesmen are apparently taken up almost exclusively with local questions, some of which are paltry in the extreme when compared with the welfare of the entire country. A blow is being struck at our industrial supremacy, from which we are never likely to recover. Trade must go to that country that is most active and best supplies the wants of the world as regards cheapness and serviceability. If any nation is able, by longer hours of labour, lower wages, and a smaller margin of profit, to compete with us, we have no objection to offer; the mistake lies with us, and so must the consequences. It is necessary, however, that there should be all the elements of a fair competition. It is an important question in this connection how far foreign consuls may, with dignity and propriety, assist the commercial enterprises of their countrymen, especially when they are of a national as well as of a private character. The rules of the consular service at present are extremely rigid, and our officials

stand too far outside the limits of justifiable and perhaps necessary assistance. They seem to think their duties consist almost exclusively in redressing complaints. Something of a more friendly and positive nature is perhaps needed. Our officials stand too much apart from, and assume to be superior to, the mercantile classes. The opposite extreme, which was the practice pursued formerly by all but the two great western Powers, was to employ merchant consuls. This was a condition not free from difficulties. It must be remembered, at the same time, that consuls are, after all, appointed to promote the interests of their country and countrymen, and if these can be better served through commercial channels than by isolation within the labyrinths of high policy, it is difficult to conceive any valid reason against the change. There is a difficulty, be it understood, in bringing Chinese officials who stand at the top of the social ladder in China in connection with merchants who are foreign, and who for the most part do not speak the language, and who, from the Chinese standpoint, stand at the bottom of the social scale. The consuls seem the only people qualified to bridge this wide gulf. These remarks bear exclusively on mercantile relations through the Chinese officials. With the corresponding merchant class in China no difficulty exists. The above remarks presuppose that diplomatic and consular help is being somewhat largely extended in China to the merchants of certain nationalities. In looking after our own interests we must be careful to recognise also the legitimate interests and just susceptibilities of other nations.

In conclusion, and with every apology for these rambling remarks, we may add that China, if judged by such tests of civilisation as the condition of her roads and the degree of respect paid to women, cannot be said to stand high. China owes her present advance in numbers, industry, and wealth mainly to her peaceful character and policy. She made no progress in the arts of life, when she was, as in the time of Confucius, 500 b.c., divided into fifty or more feudal states. Her experience is ours. How foolish, therefore, to seek to dismember our empire. By the excellence of good government, giving security and freedom to all owning her sway, China has induced the outlying nations on her borders to range themselves voluntarily under her. These weaker nations of Eastern Asia, since they could look no higher, looked up to China, and to her they are indebted for whatever advance they have made

in just government, industry, and the arts. Hence the pride and conceit of universal empire which this has engendered in the minds of the Chinese—an arrogance that has brought them nearly all their troubles in the past—but which is fast disappearing before closer contact with the superior westerns. The Chinese empire exhibits the results so far of a peaceful policy; and in the language of Dr. Williams, there can be but one wish, that these hundreds of millions of our race may be Christianised and elevated from their present ignorance and weakness by a like peaceful infusion of the true principles of good order and liberty.

X.—*On the defectiveness of the Eye-spot as a means of Generic Distinction in the Philodinaea, with a description of two other Rotifera.* By WILLIAM MILNE, M.A., B.Sc.

[Read before the Society, 3rd February, 1886.]

THE following remarks refer to those Rotifera which have a proboscis and horny outgrowths at the lower extremity of a foot which is retractile like the tubes of a telescope. They form Ehrenberg's Genera *Callidina*, *Rotifer*, *Actinurus*, and *Philodina*.

Ehrenberg adopts the presence or absence of eye-spots as his first means of subdivision of the above group. Now there is some defect here, as his genus *Callidina*, including all those without eye-specks, contains two certainly very distinct genera; and more than that, the one genus consists of a species with eye-specks and others without—without a doubt belonging to the same genus—and differing in some very important points from the other.

I have also come across what I believe will turn out to be a true Rotifer without eye-specks. So that it would seem that the eye-spots, though good for specific, have no value as generic distinctions.

The following arrangement does not dissociate manifestly similar forms, at least as regards some 19 species I have examined:—

I. Those which have a double arrangement of part of the trochal cilia of a distinctly rotulate character.

II. Those which have this double rotulate part suppressed or aborted.

This latter is Ehrenberg's *Callidina*, as far as I can make out from his figures, but not Dujardin's:—

I. (1) Those having 4 toes:— *Philodina*.

(2) Those having 3 toes.

2. (a) Those having the pre-intestinal part decidedly shorter than the post-intestinal or post-anal part:—*Rotifer* and *Actinurus*.

(b) Those having the pre-intestinal part decidedly longer than the post-anal.

I propose to call this genus *Macrotrachela*. It includes *Callidina constricta* of Dujardin. His special point between Callidina and the others of the Philodinaea is the feeble development of the wheels. But the above genus includes at least two species with wheels as large and well developed as *Rotifer vulgaris*.

The last two genera are very readily distinguished from each other, *Macrotrachela* having so proportionately short a foot, also a rather penguin-like appearance seen sideways, owing to the greatest weight being back towards the anal segment, which is very eccentric.

As it is not necessary for the purpose of this paper to try to give anything like a full description, especially of the organisation and development, which I intend to return to again in another paper, I shall give very little about Philodina and Rotifer, as they agree in the main with those of Ehrenberg.

GENUS PHILODINA.

Philodinaea having well developed wheels and a ciliated adhesive proboscis; also having horns on the retractile telescopically jointed foot, which ends in four soft muscular toes.

All I have yet seen of this genus have two coloured eye-specks on the muscular mass, between the tactile tube and the mastax.

This triangular mass, with its two basal adjunctive smaller masses and the coloured eye-specks, give the oddest resemblance imaginable to the face, ears, and eyes of a fox.

Philodina aculeata (var.). (Plate I., Figs. 5, 10.) In general appearance something like *R. Neptunius* (Plate I., Fig. 1). The wheels also similar, but the proboscis not quite so far advanced in front. In the older forms the integument takes a stiff, leathery, stippled appearance. The foot—measured when stretched from the anus—about the same length as the pre-intestinal part, measured to back of mastax. The two ankle horns are nearly twice the width of ankle—measured in front of their bases. There are four toes—two stout longer ones scarcely half the width of ankle, and two shorter slenderer ones about half the others.

The tactile tube (Plate I., Fig. 10) is long and trifoliate at the end, with a bud in the central cusp, from which spring the setae. The dental bulb has three teeth on each part.

In every example I have seen there is the same arrangement of the body spines (Plate I., Fig. 5), and the same number 8. In

Ehrenberg's figure the number is indefinite, or at anyrate large. Here there are always three pairs pointing backwards on the dorsal surface, and one pair lateral pointing forwards. There are two red eyes.

GENUS ROTIFER.

Philodinaea, having well developed trochal wheels, an adhesive ciliated proboscis, the pre-intestinal part short, less than the post-anal, which is long and tapering and not eccentrically swollen anywhere. There are horns at the ankle, which is terminated by three soft muscular toes.

Rotifer Neptunius. (Plate I., Fig. 1.) Having two wheels larger than *R. vulgaris* and a very long proboscis—one-tenth the length of the whole body. It is not so slender as *R. vulgaris*, and has its foot shorter in proportion, being not much longer than the neck. It has two very long horns, fully twice the width of the ankle and jointed, also three toes, two of them very long, $2\frac{1}{2}$ times the ankle, and jointed, and a third short one. The part between horns and toes when shot out is also long and slender.

There are two bright red eyes in the proboscis, which has four palpi at the end. The perforate tactile tube is terminated by setae.

The dental bulb carries two teeth. There is a large intestine at the end of a long stomach. There is a contractile vesicle, as in all the Philodinaea—there is one Rotifer, however, in which I have not satisfactorily made it out. A water vascular system exists, with numerous vibratile tags. The integument in older specimens becomes leathery-looking and stippled. It is viviparous, as are all the species of Rotifer; and young ones may be seen feeding alongside the parent within half a minute after birth, and about two-thirds in size. Length, $\frac{1}{37}$ inch.

I have taken this Rotifer to be the same as Ehrenberg's *Actinurus Neptunius*, though not fully satisfied that the details quite agree.

In his drawings the horns are given not nearly so long as in *P. macrostyla*, whereas, I find them fully longer in *R. Neptunius*. He shows a jointing on them, however. He gives the toes equal in length, and shows no joints on them. I always find the short third one, though it is just possible that the third is not fully protruded, though I think not; also I always find them pointed and jointed, and telescopically too.

GENUS MACROTRACHELA.

(Plate I., Figs. 2-4, 6-9, Plate II., Figs. 6, 7.)

Philodinaea having a double rotulate arrangement of the trochal cilia well in advance of the large buccal funnel entrance. The pre-intestinal part is decidedly longer than the post-anal part. The neck is round and fleshy looking; there is a high dorsal swollen ridge passing over the anal segment, giving a very gibbous and characteristic appearance.

The foot is very short, in some cases about $\frac{1}{15}$ of the whole length, of not more than 3 segments, counting the horns and all below as one. The horns as a rule are short, and the ankle with toes usually a short conical stump (Plate I., Fig. 3). There is a strong whorl of cilia on the short proboscis. The foot muscles are very heavy, and help to give the gravid appearance to the anal segment. The general shape, viewed dorsally when stretched, seems to be a gradual narrowing from the cloaca forwards.* They are non-viviparous. I have seen none with coloured eye-specks, but *M. constricta* has two round green vesicles, in a position corresponding to those of Philodina, which Ehrenberg would have called eye-specks.

Macrotrachela tridens. (Plate I., Fig. 2.) Long, narrow, and vermiform, with a strong whorl of cilia on its short proboscis. The neck is very long, the longest proportionally of all the following, being nearly as long as intestinal part. The foot is very short. The two horns are mere points about $\frac{1}{3}$ ankle; the 3 toes are also very short. The tactile tube is about half width of neck measured at its point of attachment. The mastax is seated very deep in the breast and has a three-toothed bulb. The wheels are constricted, similar to Fig. 6, Plate I.I. It moulds its food in the aesophagus into large pellets, like certain Infusoria, and the whole body cavity looks like one churning mass of these pellets, having the diameter of a threepenny piece when magnified 350 times. The stomach is enormously long and convoluted, and this is how the whole appears as one mass. These pellets may be seen being extruded still retaining their shape. This species has a very peculiar habit, when creeping, of, instead of holding firmly with the proboscis in one position till the foot is fixed, skimming or skurrying the proboscis along the glass about

* When they are pulling themselves up by the proboscis the after weight often whirls them round. There seems to be a water vascular system in all.

its own length, drawing up the foot all the while; then, catching with its toes, the proboscis is thrown forward again and the process repeated. Its speed in this way is very great, as every time its foot is set down it has gone twice its own length. Length, $\frac{1}{80}$ inch. Foot about $\frac{1}{16}$ of whole length.

Macrotrachela constricta. (Plate I., Figs. 7, 8, Plate II., Fig. 6.) This is Dujardin's *Callidina constricta*, of which he gives a very successful figure. The body, when creeping, is somewhat like *M. tridens*, only not so slender, with a squarer proboscis and stronger horns on the foot, about $\frac{1}{2}$ ankle. The foot is longer, about $\frac{1}{5}$ of whole length, and the neck about $\frac{2}{3}$ of intestinal part. The tactile tube is short and about $\frac{1}{2}$ neck. The mastax contains a bulb, seven-toothed and heart-shaped. It has two green vesicles where eye-specks are in *P. citrinus*. There is a large horse-shoe shaped contractile vesicle. It has a secretion of a layer of very light lemon particles in the muscular integument. It moulds its food into pellets, which swirl about at a great rate. Length, $\frac{1}{80}$ inch.

Macrotrachela elegans. (Plate I., Figs. 3, 9.) Has similar habits and appearance to *M. constricta*, but differs in the following points:—The tactile tube is much longer, being fully the width of the neck, with star-set long setae at end. The horns are slenderer and set at a different angle to the ankle. There are perhaps ten teeth in the dental bulb. The foot is shorter, being about $\frac{1}{16}$ of whole. Length, $\frac{1}{70}$ inch.

Macrotrachela bidens. Similar to *M. constricta*, except in having a dental bulb of rounder outline, and carrying only two teeth. It has a longer foot and a longer slenderer proboscis. The wheels are similar, and it moulds its food in the same way. The tactile tube about $\frac{1}{2}$ neck. Length, $\frac{1}{70}$ inch.

Macrotrachela aculeata. (Plate I., Fig. 6.) I have not seen many specimens of this species. It is somewhat fish-shaped, with scoloped markings over integument, and having three or four rows of spines posteriorly and one row near mastax. Tactile tube short, $\frac{1}{2}$ -neck. Foot about $\frac{1}{5}$ whole length, has two short horns $\frac{3}{4}$ of ankle, and three short toes. Length, 1.100 inch.

Macrotrachela musculosa. (Plate II., Fig. 7.) This is a strong vigorous Rotifer, with wheels large and not constricted. When creeping it proceeds very fast, and the cylindrico stretched-out body integument when relaxed instantly resumes the ovoid form, reminding one of a strong ovoid elastic jacket when stretched and let go. There is shortening and lengthening without any failure of

regularity in the dorsal outline. It has a short proboscis, with a broad frontal margin and a strong whord of cilia. The tactile tube is short, $\frac{1}{2}$ -neck, flattened and has three or four short brushes of setae at the end. The neck, like that of all of this genus is round and fleshy looking, there being no lacunae; where they exist in Rocifer, for instance, being filled with fleshy granular matter, the water vascular system being embedded in it as it were. It has a large dental bulb, with two strong teeth on each part, with a third beside these rather less than half as thick, but much thicker than the striae. There is a large triangular-granular gland just over the oesophagus, a long intestine, with a considerable diameter, containing food not moulded into peileta. The contractile vesicle is large. The horns are rather more than $\frac{1}{4}$ of the ankle, and the three toes are short. The foot is about $\frac{1}{3}$ of whole length, the neck about $\frac{1}{3}$.

There is, as in most of the others, a large buccal funnel entrance. All of this genus have the habit of lying back over the foot while feeding. This one also twists its neck round, as Fig. 7, reminding one of a long-necked ruminant. Size, $\frac{1}{10}$ inch.

Macrotrachela quadricornifera. (Plate I., Fig. 4.) This is a species at the other extreme from *M. tridens* and almost points the way to Philodina. The general shape is not unlike that of *P. citrinus*, and the wheels are very similar, but the foot is much shorter in proportion, and ends in three thick short toes. It is the stoutest of all this genus, and, along with *M. musculosa*, has the best developed wheels. It has a large dental bulb, with tooth arrangement the same. Has a large contractile vesicle, and water vascular system with tags. The perforate tactile tube is short and broad, $\frac{1}{2}$ neck, with fine setae at end. There are four horns on the foot, two on the lowest segment, and two on the first segment. The proboscis is thick and very square. Just within the exoderm is a secretion of a layer of light-coloured particles. The transverse muscular system is well developed and readily seen. The neck is about $\frac{2}{3}$ whole length, the foot being about $\frac{1}{8}$. Length, $\frac{1}{10}$ inch.

GENUS CALLIDINA.

(Plate II., Fig. 5, 10.)

Philodinæa having the wheels aborted, a non-ciliated proboscis, and the retractile foot terminated by three soft toes.

Just between the extended wheels and the proboscis in the Philodinaea is a more or less elevated part, which I have called the brow. In *R. Neptunius* it is a slight double curve; in *M. musculosa* it is a double elevated ridge (Plate II., Fig. 7); in *M. constricta* it is a triangular ridge (Plate II., Fig. 6). The brow is constant when viewed in the same species from the same angle.

The trochal arrangement of Macrotrachela, especially of the more constricted ones, points the way to Callidina.

The collar from the ventral side continues round and up the back of the wheels to the brow, the wheels rising out of the anterior part of this enclosure. Round the roots of these there is a gutter or *lead* setting towards the buccal entrance, and richly ciliated, as are also the ventral sides of the pedestals of the wheels. Suppose these wheels suppressed, and the whole becomes a ciliated lead to the buccal funnel entrance, with a rim or collar—just the trochal system of Callidina, only the lead is more extended, of the shape of a fish split open or in some of a horse-shoe, with a triangular brow in front turned down. The aborted wheels are represented by two wrinkled membranes, with a connection backwards (Fig. 5).

The proboscis proceeds back behind the brow to the first segmental ring (Fig. 10.) The way it wrinkles up its head shows where the aborted wheels must have been. From an examination of Ehrenberg's figures, I conclude that this genus corresponds with his Callidina. In his figures the small wheel cilia when in motion are away far behind the proboscis. Now none of the Macrotrachela have the proboscis in front of the expanded wheels, and besides the wheels when in that condition are much in advance of the buccal entrance. In Ehrenberg's figures the buccal funnel is in advance of the wheels. In fact, his wheels are just cilia on the collar, and it appears that he has merely shown these the posterior, and also the anterior cilia of the *lead* to the funnel entrance I have already described, and either did not notice or did not figure that the whole interval between was also ciliated. By filling in these cilia you get just the trochal parts of *Callidina oculata*. (Plate II., Fig. 5.)

In no possible position of the Trochal wheels of Macrotrachela, folded or unfolded, can the appearance be got as given by Ehrenberg in his *Callidina elegans*, nor does the general shape agree with that genus at all. It does so with the genus I describe as Callidina. It has a curious way of swimming—the ciliated head goes steadily forward, but the toes catch and hold till the head by its continued

impetus has pulled out all the joints and the animal is at its greatest length; then the toes let go and the joints telescope into each other, the toes, springing up to near the head, catch again, and so on, giving a curious wriggling, hopping kind of motion. It cannot hold with its proboscis, but in creeping among rubbish it aids itself by pressing the trochal cilia against the objects when drawing up the foot.

I take *Callidina elegans*, and *Callidina cornuta* from the description of its manner of swimming, to belong to this genus, though I have not seen either.

I have seen three species, however, all being two-toothed. One of these I take to be Gosse's *C. bidens*, but cannot be sure, as he has given no figure of it, yet and very little description. Another one without eyes, distinct from the above, has also two teeth in each jaw, as has also

Callidina oculata. (Plate II., Figs. 5, 10.) The body is spindle shaped and flattened. The head is very flat, and smaller than the other species. The collar has a jagged scalloped edge. There is a strong ciliary motion in the buccal funnel, which leads to a very small maxillary bulb carrying two teeth. There are two glands about the œsophagus, and a very long stomach leading therefrom and ending in an intestine with thick muscular walls. There is a contractile vesicle with water vascular system, and at least 3 vibratile tags on each side. The horns on the foot are fully the length of the ankle. The three soft toes, $\frac{1}{2}$ the horns in length, can be seen to be the prolongation of muscles which proceed upward through the foot. It is non-viviparous. There is a flat tactile tube less than $\frac{1}{2}$ the width of neck, and terminated by short stout setae. Muscles are seen proceeding from its neighbourhood forward on the dorsal surface to the front segmental ring. There would seem to be two small ones into the proboscis, on which are seated two large and brilliant red eye-spots.
Length, $\frac{1}{50}$ inch.

The following two Rotifera I believe to be new:—

Diglena? uncinata. (Plate II., figs. 1, 2, 8.) The body is fairly cylindrical from a dorsal view, but seen laterally it is gibbous. It ends in a short distinct foot, which has attached to it two very long toes— $\frac{1}{2}$ as long as the rest of the animal—divergent and decurved, somewhat scythe-blade like in appearance. In front is a hood which sideways shows very like a beak. The

truncated face is covered with strong cilia, two, or two pencils of which are more than double the length of the rest, which are themselves longer than usual. They are membranellate at the base, and flagellate like and whip about in the most vigorous manner. There is a large occipital ganglion, and just above it a pit surrounded with muscular substance attached to the dorsal integument, and probably connected by a thread with the ganglion, as in *Diglena*. Round the oral opening is a series of muscular patches extending backwards on two sides to where two foot muscles are attached. These muscular enlargements give the opening a very elastic character, and enable it to be greatly distended when swallowing large prey. Just behind these, and below the ganglion, is the mastax, somewhat oval in shape, and containing a very formidable pair of protrusile three-toothed jaws (Fig. 8). On the head are two distinct joint rings, which can be drawn within each other. Proceeding backwards from the anterior dorsal side of the mastax is a large opening into a clear walled æsophagus or stomach, which has often a wrinkled up form—the brain lobe lying over it—but often may be seen distended with food, when it occupies in an oval form $\frac{1}{2}$ the body from the mastax backward to the foot, crushing down the stomach proper. The stomach proper is conical, with thick muscular walls. On its anterior edge, and intimately connected with it, are two large, flat, wedge-shaped glands, nucleated, and containing a peculiar vesicular hollow surrounded by two or three dozen granules. From the constancy of the vesicles, and the persistence of the granules round them, I thought at first it might prove what Ehrenberg calls *Theorus*, and probably *Theorus uncinatus*, but on turning up his figures of that species I find the toes not half the relative length of those of the present species. Also the drawings show the eyes of fairly large size, and not on the stomach glands. But whether Ehrenberg's points be eyes or not, the character of eyes could never be allowed to the aggregation of granular points—in no way differing from other granules in the body—round a hollow in the heart of these glands. Such vesicles in corresponding position are not uncommon in Rotifera, but not so noticeable as in the present species.

There is a large ovary which extends up to the mastax and develops eggs of a great size.

A contractile vesicle exists and a water vascular system with at least two vibratile tags readily seen behind the mastax.

There are two glands in the foot, probably secretive, being

placed just at the points of insertion of the toes. A short fine seta springs from the posterodorsal surface of the foot, but is exceedingly difficult to detect. Up either side from the foot run two very strong muscles, one affixed to the second occipital ring, the other to somewhere between the mastax and brain lobe. This little creature has a curious way, when moving along, of suddenly, and with exceeding quickness, switching itself back on its toe points, head over and back again, the motion being somewhat comparable in its quickness and unexpectedness to the springing of the Infusorian *Halteria Grandinella*. The hood is used for feeling up the grass stems, and then, when food is being taken in, closes down towards the mental edge, keeping the particle from slipping or being knocked away when the teeth are being shifted forward on it.

No eyes have been seen.

This Rotifer undoubtedly belongs to the same genus as the Rotifer I described under the name of *Pleurotrocha mustela* last session. This latter, Mr. Gosse, our first authority on Rotifera, believes to be *Notommata felis*, and thinks that an eye-spot should be found on it. Subsequent examinations, however, on my part have failed to detect any such spot.

Mr. Gosse has very kindly informed me that the present species is unknown to him, and from the slight sketch I sent him, thinks it may probably prove to be a Diglena from the nature of its jaws. I hope the classification adopted in the monograph about to be published by him and Dr. Hudson will admit of the two being placed together. They have the same frontal beak projection, the same jaws exactly, and used in the same way, the same large and distensile part between the mastax and stomach proper, at times swollen with food, which is retained and digested at least partly. Length, $\frac{1}{67}$ inch.

Pre-intestinal part, nearly	-	-	-	-	-	-	-	$\frac{1}{3}$
Intestinal	"	-	-	-	-	-	-	$\frac{1}{3}$
Foot,	-	-	-	-	-	-	-	$\frac{1}{2}$
Toes,	-	-	-	-	-	-	-	$\frac{1}{3}$

Stephamops Stylatus. (Plate II., fig. 3, 4, 9.) This Stephanops I have not seen anywhere described. It is not in Ehrenberg, nor is it in the list of the genus given by Dr. Hudson in the August, 1885, number of the Journal of the Royal Microscopical Society. It is enclosed in a flattened transparent lorica, tougher than hard, the oval dorsal surface of which is prolonged forward in a

spoon shaped hood, and backward down as far as the middle of the foot, and there rounded off without any terminal spines.

The trochal disc is truncated, and nearly in a line with the ventral surface. It has a few small cilia round the oral opening, in front of which is a central spoon of uncinate styles, on either side of which a very strong one also uncinate is placed, and at their roots a few smaller ones. These styles are like the ventral ones of the Infusorian Stylonychia, and seem to be ambulatory. Just at the very front edge of the trochal part are two or four cilia, very long and pliant, and of a flagellate character. From each side of the head proceeds backwards and outwards a very long, straight style membranellate at the base, and of a soft and flexible character, but not vibratile.

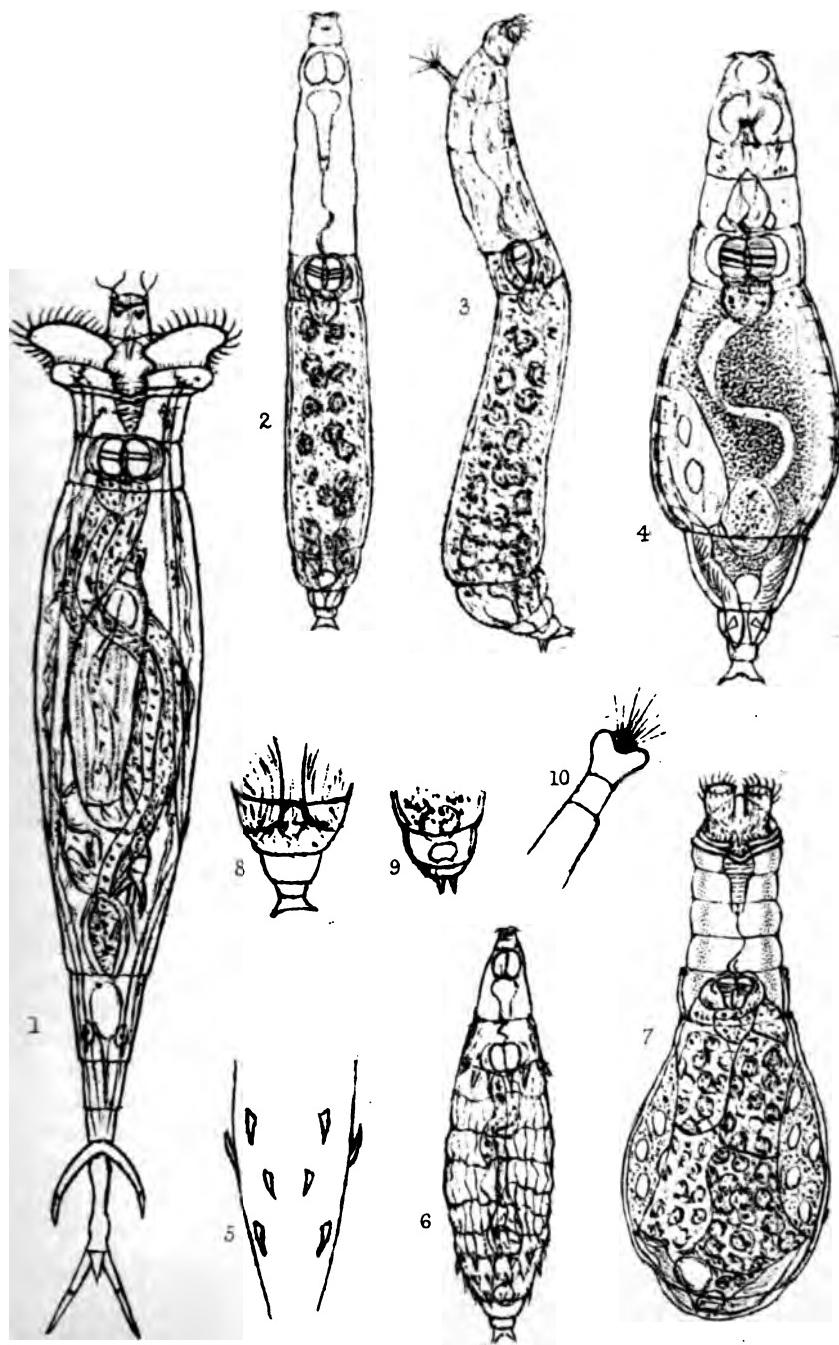
Near the bases of these two styles are two fairly large green nodules, which can be isolated, and may be considered eye-specks. No coloured eye-specks were seen. The brain mass is occipital.

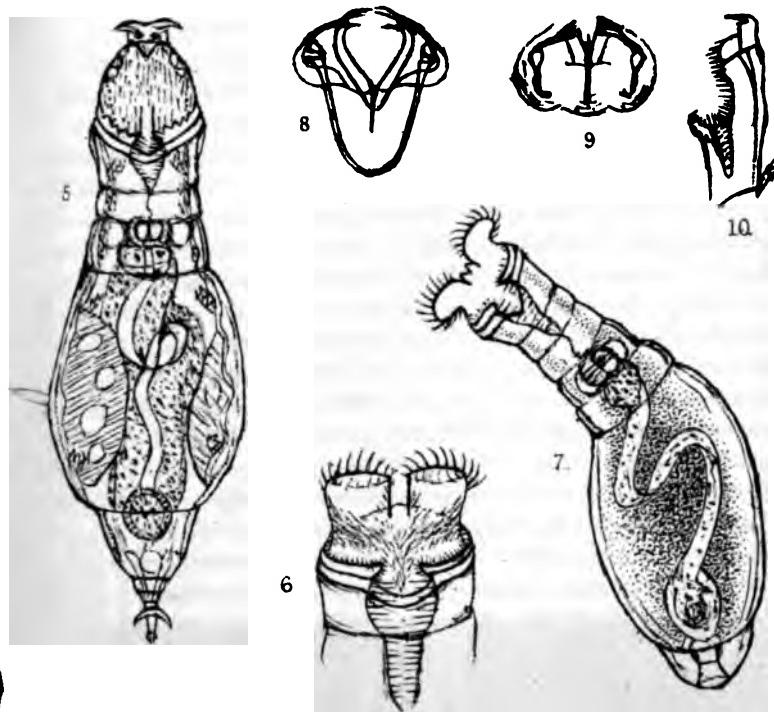
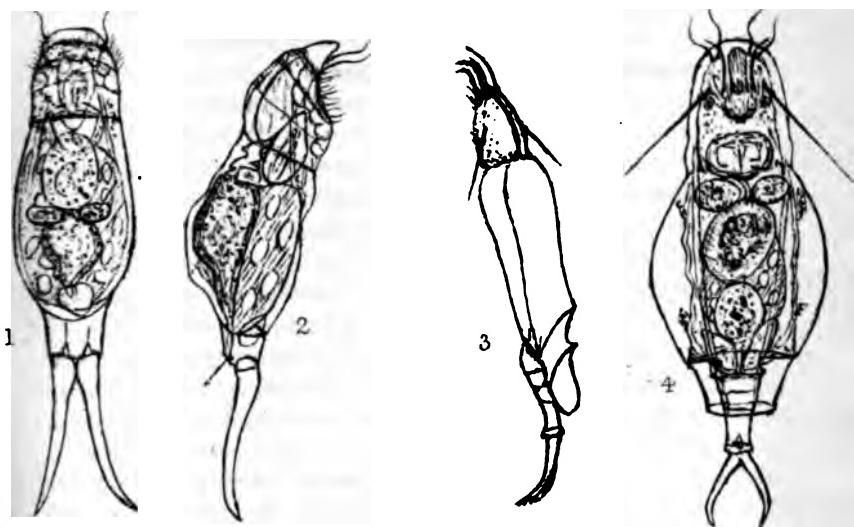
The oral opening leads to the mastax, which contains small jaws with four or five teeth, somewhat of the nature of those of *Notomma clavulata*.

From this an aesophagus leads to a stomach, with ciliated lining, which again leads into an intestine. There is an ovary on the ventral side. A water vascular system exists with several vibratile tags. The contractile vesicle is large and appears double. When it contracts, its convoluted corded surface seems to go down by the run, in two divisions, right and left of the cloaca. The foot is long, and is terminated by two long divergent and decurved toes. There are two large glands connected with the stomach, having each an internal hollow, surrounded by granular particles.

The head, owing to its uncinate styles, when viewed laterally resembles a parrot beak (Plate II., Fig. 3), and altogether the Rotifer has a very bird-like appearance, the two toes looking not unlike the long tail-feathers of a male bird. The illusion is kept up by its motions, for it is very lively, and flits about in the most graceful way, and runs up the moss in search of food by means of its uncini. It can also affix itself by its toe points.

There are two muscles affixed at the anterior end of the foot and running up each side, over what might be called the shoulder, to the front, other two proceed from the same place, and seem to unite about the mastax and separate there again onward and have ending near the others. These muscles are very strong, and the creature sometimes makes a curious use of them, for it may often







be seen keeping itself in one position, stretching its lorica by pushing forward the shoulders and backwards the foot, then relaxing, and so on, and seeming to derive some pleasure from it, as it continues the process for a long time. Length, $\frac{1}{10}$ inch.

Taking the pre-intestinal part as	14
Then, to end of lorica is	16
Rest of foot,	4
Toes,	6
Length of lateral styles,	10

DESCRIPTION OF PLATES.

PLATE I.

- Fig. 1.—*Rotifer Neptunius*, ventral view, with foot partly drawn up, and toes shown as they are when fully stretched out.
 , , 2.—*Macrotrachela tridens*, dorsal view when creeping.
 , , 3.—*Macrotrachela elegans*, side view when creeping (Fig. 9) same, foot dorsal.
 , , 4.—*Macrotrachela quadricornifera*, dorsal view when creeping.
 , , 5.—*Philodina aculeata* (var.) showing spines. Fig. 10—Tactile tube of same.
 , , 6.—*Macrotrachela aculeata*, dorsal view.
 , , 7.—*Macrotrachela constricta*, ventral view, when wheels are expanded.
 , , 8.—Foot of same, dorsal view.

PLATE II.

- Fig. 1.—*Diglena uncinata*, dorsal view.
 , , 2.—*Diglena uncinata*, side view.
 , , 3.—*Stephanops stylatus*, side view.
 , , 4.—*Stephanops stylatus*, dorsal view.
 , , 5.—*Callidina occulata*, ventral view, with foot partly drawn up.
 , , 6.—*Macrotrachela constricta*, ventral view of head, with wheels expanded.
 , , 7.—*Macrotrachela musculosa*, ventral view, feeding with wheels expanded, and lying back over the foot.
 , , 8.—*Diglena uncinata*, jaws, with muscle loop for working them.
 , , 9.—*Stephanops stylatus*, jaws.
 , , 10.—*Callidina occulata*, side view of head.

XI.—Description of New Signal for River Piers and Railways.By **GEORGE S. BUCHANAN.**

[Read before the Society, 3rd March, 1886.]

THE danger from collisions, during the summer months particularly, between the steamers calling at the smaller piers on the Firth of Clyde is a subject which has attracted a good deal of attention for the last year or two, both from the authorities and from the travelling public.

It is true that, owing in great measure to the skill, caution, and temper of the captains, no accident involving loss of life or serious personal injury has yet occurred, but as several vessels have been more or less severely injured from collisions at these piers, it would be a mistake to trust to this immunity always, and it is surely far better to do something to reduce the risk of accidents before one has actually taken place than to wait till it is forced on us by some awful calamity.

Year after year, the number, size, and speed of our river steamers go on increasing, and there does not seem to be any appearance of any falling off in this, as from the way in which the fastest and best boats are favoured by the public, they are practically encouraging this competition, and are thus keeping up that spirit of emulation in the steamboat owners which has had the result of making their vessels the finest river steamers in this country at any rate.

But with this keen competition and the consequent desire to shorten the length of the journeys as much as possible, comes in the element of Danger.

The time estimated for landing and embarking passengers and luggage at the various piers is reduced to a minimum, and when any unforeseen detention occurs—a thing steamboat traffic is very liable to, and which all who travel much must have experienced—not only is the one boat thrown out of time, but her unpunctuality affects others also, and occasion is given for a dangerous competition for precedence at the piers, particularly when there is little interval between the advertised hours of sailing.

Taking Innellan I find that in July last there were advertised to start from it—

Before 9 morning, 7 steamers going up, none going down.

From	9	till	10	none	"	3	"
"	10	"	11	1	"	1	"
"	11	"	12	1	"	3	"
"	12	"	1	1	"	2	"
"	1	"	2	1	"	2	"
"	2	"	3	1	"	1	"
"	3	"	4	3	"	4	"
"	4	"	5	2	"	1	"
"	5	"	6	4	"	2	"
"	6	"	7	2	"	2	"
"	7	"	8	1	"	2	"
After	8			2	"	3	"

Now, take the case of one vessel going down, timed to arrive at 4·40, and another going up at 4·30, if the latter, from some cause, is 10 minutes late, it comes that both may be approaching the pier at the same time, in different directions and at apparently the same distance from it. The down captain probably thinks he should get in as he is at his time, and the up one because his passengers wish to catch a train at Greenock. Which is to yield? I suspect it is often decided by which of the captains appears to be the most determined to have his way. Again, two or three vessels may be approaching the pier in the same direction, but on lines somewhat apart from one another, and possibly at much about the same distance from the pier, here again they have to decide for themselves, but the one who takes the pier is often so closely followed by the others that I have seen them requiring to back off to prevent a collision, and if there be any wind, position, steerage way, and command of the vessels are for the time lost, and additional delay is experienced when it comes to the turn of the other vessels to take the pier.

Now surely this is a sort of responsibility which it is neither fair nor proper to lay upon the captains—it is the pier master who should decide in these cases, and have the means of easily making known his decision to the captains of the approaching vessels while yet a considerable way off.

The Pilot Board, who have charge of this department of the management of the River, either have not had authority in this

matter or have not had adequate powers to enforce this authority, and it has therefore hitherto been a difficulty between them and the proprietors of the Piers in what way it was to be arranged. But I understand they have applied to this Parliament for a Bill to enable them to secure that signals will be erected at the various Piers, and that competent people will be stationed to work them. If the access to a Pier could be regulated like a Railway Station by distant and home signals, that system might be adopted, but the directions of approach to a Pier are far too divergent for any system of that kind to be applicable.

What appears to be wanted is some sort of signal which, in a way easily seen and understood, and with the least possible action on the part of the attendant, will indicate, it may be to half a dozen vessels at once, which of them is to come in and which are to lie off.

A plan for such a signal occurred to me, and I have submitted it to the Pilot Board for their consideration along with others which may be sent in to them. I have been allowed to bring it before this Society, and I will now describe it to you.

The important part of it is a bar or arm permanently fixed to a mast or pole on the pier, and projecting horizontally from it at a convenient height, in a line at right angles to the front of the Pier.

The principle is, all signals made on the upper side of this bar apply to vessels going up a River or Loch, and signals made on the down side, to vessels going down.

Where the traffic is small, a single semaphore arm turning on a pin in the bar, about half way between the mast and the end of it, is all that is necessary, and according as this moveable arm is set pointing up or down, the Pier is open to down and up vessels respectively. It is safer to make this moveable arm double, the one arm being at right angles to the other, so as to render it impossible to have both up and down sides of the bar open at the same time.

Where the traffic is greater, and it may become necessary to signal to two up and two down vessels at the same time, a vertical bar about the same length as the horizontal one is fixed to it at right angles in the form of a cross. The two upper quadrant spaces apply to two up-going vessels more or less abreast of each other, the one next the mast referring to the inshore vessel and the other one to the outer vessel; similarly, the lower quadrants apply to inshore and outside down-going vessels.

The movable part is a circular disc revolving on the centre of the cross arms, with one-fourth part of it cut away. It is evident that thus it can only cover or fill up at any time 3 of the 4 quadrant spaces, leaving one of them always open; and the one thus left open is intended to indicate to the vessel, whose position corresponds to it, that she is to come on, and that the pier is for the time closed to all others.

It can also be arranged to signal quite distinctly to 6 vessels, 3 up and 3 down, and all approaching the pier at the same time. For this purpose 2 arms are fixed at their centres to the horizontal arm, and making with it and one another angles of 60°, thus forming 6 sector spaces, 3 above and 3 below the horizontal, applying respectively to inshore, centre, and outside of 3 vessels approaching the pier in the same direction.

The movable part is, as in the previous case, a circular disc, but with one-sixth of its surface cut out; it can therefore fill up only 5 of the 6 sectors, and the open one, as before, indicates which vessel is to come on.

There are a great variety of ways of working the movable disc. It may be done by an endless chain, by jointed levers, by cranks, by rack and wheel work; but in the small working model exhibited, I suggest a very simple and inexpensive arrangement. Two or three turns of a chain are passed round the spindle of the movable disc, both ends of the chain are brought to the mast and pass over pulleys on opposite sides of it; to the one end, is attached a weight sufficient to revolve the disc in one direction; to the other end about 3 or 4 feet from the pier level is fixed an eye or ring. In the mast are fixed, one above the other, 6 studs or pins, the 3 upper being for up vessels and the 3 lower for down ones.

The pins are so placed that the distance between any two of them is exactly what the chain requires to be pulled down, in order to turn the disc one-sixth part of a revolution. The chain is of such a length that when the ring or eye on the end of it is put over the uppermost pin, the inner sector on upper side of bar is left open, thus saying "come on" to inshore up-coming boat, and keeping off all others, when the ring is put on the 2nd pin, the centre, upside sector is left open, on No. 3 pin the outside up is open, on No. 4 the outside down, on No. 5 the centre down, and on No. 6 the inside down, and the corresponding vessels are thus signalled to in turn; the back weight returns the signal to its original position when the chain is slackened.

Besides the simplicity of this arrangement, it has this advantage that there are no projecting handles to come in contact with passing luggage, and that it can very easily be entirely covered up—indeed, the whole could be checked into the body of the mast, and protected by a cover not projecting beyond it.

For use at night, red lamps are fixed one at each side at the centre of the cross arms, so as to show red to up and down vessels, a white light is pivotted, so as to hang perpendicularly in all positions, in a frame at the centre of the outer edge of the open sector, and revolves with it. The position of this white light, in reference to the red ones, indicates in what position the open sector is standing, and, consequently, which vessel is to come on, all others keeping off.

This plan of signal, which I believe to be perfectly new, appears to me to possess the following advantages:—

- 1st. It is all but self-interpreting—once seen it is understood.
- 2nd. There is no code to be learned and remembered.
- 3rd. It in no way depends on coloured signals, which are difficult to make out in thick weather.
- 4th. No combination of signals is ever necessary.
- 5th. A single action of the attendant indicates which vessel is to come on, and which are to lie off, whether going up or down, and
- 6th. It is impossible by it to signal to more than one vessel to come on at the same time, and this I think is a very important thing to do.

XII.—*On an Electric Safety Lamp for Miners.* By JOSEPH
W. SWAN, M.A.

[Read before the Society, 17th February, 1886.]

THE Royal Commissioners appointed to inquire into accidents in Mines, in their preliminary report issued in 1881, publish a table showing the number and nature of the accidents which occurred during the 30 years ending 1880. From this table it appears that the number of accidents in mines relatively to the number of persons engaged in mining operations has, during the period referred to, largely decreased.

The great improvements which have been made in mine-management and in mining machinery have, in round numbers, reduced the ratio of accidental deaths to miners to one-half what it was at the beginning of that period; whereas the ratio in 1851 was one death by accident in every 219 of the persons employed in mines, in 1880 it was reduced to one death in every 425.

But notwithstanding this marked improvement, the aggregate number of accidental deaths in connection with this indispensable industry, in the last year of the last decade, reached the appalling sum of 1318—that, it must be added, is above the general yearly average for the 10 years ending 1880—which is very nearly 1000. Of the 1318 persons who were accidentally killed in mines in 1880, 499 were killed by fire-damp explosions—that is, almost double the usual number of deaths from this cause, the yearly average of 10 years ending 1880 being 268.

These large figures represent a great amount of sorrow and suffering of the most terrible kind, and force upon us with extreme urgency the question, can nothing more be done than has been done to diminish this fearful mortality?

Have the resources of science been availed of to the uttermost, or are there yet some untried means of prevention which it offers?

I do not propose to answer that question fully, but, as a contribution towards its object, I hope to be able to show you the

feasibility of a different, and I believe a safer, means of mine-lighting.

In the evidence given by mine-managers and mine-inspectors before the Royal Commissioners, a very general opinion was expressed, in reference more particularly to accidents in coal pits, that *a safer Lamp and more light*, would tend to reduce their number, and these are the two points in regard to which I have aimed to make improvements.

I have endeavoured to make an absolutely safe lamp, that will give much more light than is given by the usual oil lamp.

The Safety Lamps of Davy, Clanny, and Stevenson are doubtless safe under certain conditions, but under other conditions, and these by no means uncommon, they have been proved to be unsafe. When the atmosphere of a mine happens to be in a highly inflammable state by reason perhaps of a sudden and large outburst of gas, or in consequence of a temporary derangement of the ventilating apparatus, if any of these lamps are exposed to an unduly rapid current of this air, an explosion will ensue. I am aware that there are now lamps safer than either the Davy or the Clanny or the Stevenson, but these are only safe (if they are ever absolutely safe) when in perfect order, and they may sometimes not be in that perfect condition. Moreover, the additional safety of the newest forms of Safety Lamp has in most cases been obtained at the expense of light; and however safe a lamp may be as regards explosions, if it does not give ample light it can hardly be properly called a safe lamp, because accidents from falls of the roof and sides of the mine workings are increased by want of light, and work is impeded by it to such an extent that there is a strong tendency to go to the very verge of danger from explosions by using naked lights to escape the more constantly pressing danger from falls of roof and sides, and other accidents apt to occur from want of light, and to obtain the other advantages which attend working in a good and sufficient light.

Considering then the difficulty, not to say impossibility, of insuring absolute safety, together with a sufficient quantity of light, by the use of the principle of the Davy lamp, I have been led to enquire into the feasibility of more effectually, more safely, and more sufficiently, lighting mines by electricity; for by means of electricity it is possible to produce light without combustion, and therefore without contact with the atmosphere surrounding the light, and there are not the limitations in the quantity of light

conjointly with safety, when this means of lighting is used, which exist in connection with the ordinary means of mine illumination.

An attempt was made about twenty years ago to apply electricity to mine lighting. The apparatus was the invention of a French gentleman, and consisted of a battery of 3 or 4 cells, an induction coil, and a lamp. The battery and coil were carried strapped on the miner's back, knapsack fashion. The lamp was a Geissler tube of a spiral form, and was carried in the hand. On touching a button, the tube was illuminated with a faint bluish-white glow, of certainly less than the $\frac{1}{15}$ th. of a candle power. I mention this as showing a desire for electric light in mines even before the means existed for producing it in a practicable form.

It was a large contribution towards making this idea practicable when the discovery was made that a strip of carbon in a vacuous glass bulb could be maintained in a state of white heat so as to emit a useful light by passing a small current of electricity through it—the discovery of the incandescent lamp, in short; and that was really the initial step towards mine lighting by electricity. No sooner was that discovery made than the most sanguine anticipations were entertained as to the revolutionary change that would be immediately effected by the introduction of electric light into coal mines.

But things like this never move so quickly as we expect. It needed a special form of lamp to be put into the hand of the mining engineer, and also that the mining engineer should be found ready to face the minor difficulties and troubles which inevitably attend every departure from established routine.

It needed, moreover, a mine proprietor to be forthcoming who was not afraid of expense. I believe *Glasgow* produced the last named essential to the introduction of electric light into a coal mine in the person of John Watson of Earnock.

Soon after the production of incandescent lamps had been put on a practical basis, I devised a form of portable or semi-portable lantern to contain an electric lamp for mining purposes, of which this is a slightly developed specimen.

This, the earliest form of Miner's Electric Safety Lamp, if we omit the Geissler tube apparatus which I mentioned, requires an external supply of electricity, and flexible cords connecting it with the mains which come from that source of supply.

Its use presupposes a dynamo worked by a steam-engine, and insulated electric mains substantially laid along all the workings

in which it is used, and also the extension of these from time to time with the progress of the mine workings. The light given by the lamp may be as much as 10 or 20 candles.

This form of lamp has not to any great extent recommended itself to the judgment of mining engineers.

It is objected that the cost of laying and maintaining the electric mains would be excessive, and especially so since they would require frequent change of position, and that danger would not even then be wholly avoided, for in the event of a conductor being cut through by a fall from the roof or sides, a spark would be produced which might ignite explosive gas, if any happened to be surrounding the wire at the point of severance; and even if no harm of that kind were done, the lights connected with that part of the circuit would be extinguished. Cables of the size necessary to be used for carrying the current to a number of lamps at a considerable distance are usually very strong, and I do not believe the danger arising from the remote chance of their accidental severance to be appreciable; but it is undeniable that the *cost* of laying such cables would be very considerable, and *that* in itself is an effectual objection to this form of lamp being used generally throughout a mine.

I was told when I first showed this lamp to a company of mining engineers, that cost would prove an insuperable objection, and I was urged to endeavour to devise a portable combination of a lamp, and a battery to light the lamp.

The object of my being here to-night is to show you how far I have succeeded in the attainment of this end.

To completely meet the wants of the case, it appeared to me that two kinds of lamp were required, one kind for the regular mine lighting, and another kind for exceptional use after an explosion or derangement of the ventilation.

Accordingly, I have devised two forms of battery for these different purposes. The battery, in that form of the apparatus intended for regular use as a substitute for the oil safety lamp, is a modification of the secondary battery of Planté. The positive element of the cell is a lead tube, and the negative element a cylinder of peroxide of lead, contained within the tube, a space being left between them for the electrolyte. The size depends on the number of cells in the battery.

In the battery I have here there are seven cells, 6 inches long and $1\frac{1}{2}$ inch diameter. Each cell is fitted into an ebonite

tube, and the seven tubes fit into a cylindrical outer case, with a screw lid, and a handle on the top.

I have nearly finished another and simpler form of battery, in which there will be only 4 cells. I am not very sanguine of any advantage being obtainable from reducing the number beyond four. But it is possible to construct a one cell lamp, and in fact I have one such here. The great advantage of a secondary battery is that it costs very little either in power, or labour to re-charge it.

Three horse-power would be ample to maintain 500 lamps in continual action, that is, 500 being always in use, and another 500 in process of being charged.

The arrangement of the lamps while connected with the charging circuit is extremely simple. Conducting wires from a small dynamo driven by steam power will be fixed at the back of a long bench, and as many branch wires will come from these across the bench as there are series of lamps to be charged. Connection with the lamp will be made by simply placing it upon a pair of charging prongs, in which the branch wires terminate, and which project upwards from the table and enter the charging holes at the bottom of the lamp. So that the placing of the lamp in position for charging is an exceedingly simple matter, and requires little time. Probably it will be found convenient to charge 5 or 10 lamps in series, and to have an indicator of some kind in each series to show that the circuit is complete, and that the proper amount of current is passing. A small piece of very thin platinum wire within a glass tube would be a convenient form of indicator for this purpose.

There is every reason to believe that this kind of battery will be durable, and that therefore the cost of maintaining light by this means is limited almost wholly to the engine-power and the labour connected with re-charging the cells, added to the expense of renewing broken lamps.

All these together would not, I believe, exceed the cost of obtaining the same amount of light, or even a smaller amount of light, by means of oil lamps.

It, therefore, is an economical as well as a safe light, comparatively with that produced by oil.

Considerable advantage is obtained by the perfect manner in which the light of the lamp is reflected in the direction in which it is most required, by a white reflector being placed behind the

glowing filament. Every portion of the space in front of the lamp is equally illuminated—roof, sides, roadway, and front.

The battery is locked in the usual way to prevent its being tampered with.

In one of these lanterns there is a provision for two lamps being in position at the same time, the one lighted and the other in reserve, in case the lighted one should go out. The switch gives the power to turn either lamp on or off, but not to turn on both together.

The light is very steady and lasting. With this size of battery it has an average power of $2\frac{1}{2}$ candles for 10 hours, and at the end of 12 hours it is still a serviceable light. This is two or three times as much as the best safety lamp gives.

The diagram shows the power of the light at different times during 12 hours.

The measurements were made in the laboratory of Sir Frederick Abel. At first the light, as measured in the photometer, was $2\frac{3}{4}$ candles. After 10 hours it was $2\frac{1}{4}$, and between the 10th and 12th hour there was a gradual fall to $\frac{3}{4}$ of a candle.

When I had produced the electric safety lamp in this comparatively perfect condition, I showed it to the mining engineers connected with the Mining Institute at Newcastle, and I think I may say that it was well received. A deficiency was, however, pointed out. It was objected that the incandescent filament in the electric lamp, being completely cut off from contact with the air of the mine, was incapable of showing the presence of fire-damp in the way it is shown by the elongation or extinction of the flame of the ordinary safety-lamp, and it was said that if I could add a fire-damp indicator, the apparatus would then constitute a quite perfect means of mine illumination. Searching for the means of effecting this very desirable object, I found that Mr. Liveing had devised a method of indicating the presence of fire-damp by the unequal incandescence of two platinum wires heated to a red heat by an electric current, one wire enclosed in a glass tube containing pure air, and the other in a cage of wire gauze, open to the air of the pit.

As hitherto made, a magneto-electric machine formed part of Liveing's indicator, and it was consequently as large and heavy as the entire safety lamp. As I had in my lamp battery a sufficient means of heating the wires, it seemed that the principle of Liveing's apparatus could be applied so that the indicator would be a small

appendage to it. I have had this carried out, and here is a lamp furnished with a fire-damp indicator.

By turning the switch button so as to extinguish the light of the lamp, and shift the current on to the indicator for a moment, it can at once be seen, if there is an absence of fire-damp, that both wires are alike red-hot, and if there is fire-damp in the air, *by the exposed wire becoming brighter than the other*. If the proportion of marsh gas in the atmosphere is small, the difference in brightness is small; and if there is much gas, then the exposed wire is much the brighter, and even continues to glow after the current is turned off. A quarter or half per cent. of fire-damp is detectable by this means. The cage containing the exposed wire is lined with many folds of very fine copper gauze.

In this combined lamp and fire-damp indicator I hope that all the objections that can be reasonably brought against an electric safety lamp have been completely met.

Now I come to speak of the primary battery lamp. It is intended to supply the want, unhappily too often felt, of a lamp which will give light in an atmosphere in which an ordinary lamp will not burn. Such a lamp in connection with Fleuss's breathing apparatus is wanted after a pit explosion, for search purposes, and in putting deranged ventilating apparatus right.

Even though the electric safety lamp be found as completely practicable and as safe as I believe it to be, yet it cannot be expected that it will immediately be universally adopted. There will be, for a long time to come, mines unfurnished with the means of charging secondary batteries at the moment when an accident has happened.

I propose to meet this case by providing a primary battery that possesses all the advantages of the secondary battery, except economy in use and maintenance—unimportant deficiencies in the circumstances contemplated.

The transformation of the secondary battery I have described into a primary battery is made by simply substituting tubes of zinc for the lead tubes of the secondary battery, the peroxide of lead cores remaining the same as in the secondary battery.

This simple modification produces a most effective primary generator of electricity, having a higher electro-motive force than any other voltaic combination in common use, and maintaining its power with great persistence.

The zinc and lead peroxide couple is not new in principle; more than thirty years ago De la Rive proposed it, with only the

difference of a platinum conducting plate in contact with the peroxide, instead of a lead one, which I use.

Six years ago, Niaudet pointed out that the platinum could be replaced by lead. Strange to say, notwithstanding this, no one seems to have put the idea in practice. The cost of peroxide of lead will not explain the neglect of this most powerful electro-negative substance, for much more costly substances have been occasionally used in its place. But now that it can be re-oxidised by means of a dynamo, it is at once the cheapest and the most powerful oxidising agent that can be used in a voltaic cell.

A zinc and peroxide of lead battery furnishes a most convenient means of supplying electricity for a portable lamp, and for many other purposes. If proper arrangements were made for the restoration of spent peroxide poles, peroxide of lead ought, I think, to entirely supersede nitric and chromic acids as oxidising agents in voltaic batteries. It is certainly much safer and more convenient to keep in store a number of peroxide poles than a corresponding quantity of nitric acid. And added to that, there are the advantages of absence of noxious fumes, a single instead of a double fluid, reduced local action, and higher electro-motive force.

XIII.—*Observations on Early Guilds of Merchants and Craftsmen, with special reference to the relation in which the Guilds of Scottish towns stand to those of other Countries in bygone times.* By JAMES D. MARWICK, LL.D., F.R.S.E., Town-Clerk of Glasgow.

[Read before the Society, 17th March, 1886.]

WHEN Professor M'Kendrick asked me to read a paper here, and subsequently pressed his request with an urgency which it was well-nigh impossible to resist, I pleaded my inability to speak on any purely scientific subject. He said, however, that he desired to see a wider range of subjects introduced, and that topics of general literary and historical interest should find a welcome and more frequent place. Under these circumstances I have been induced to offer to you this evening some observations on early Guilds of Merchants and Craftsmen, with special reference to the relation in which the guilds of our Scottish towns stand to those of other countries in bygone centuries. What I have to say is, practically, a general introduction to a sketch of Scottish Merchant and Craft Guilds.

Associations for trade and commerce in Rome and its provinces were known as “*Colleges*”—the term college expressing the union of several persons in an office or for a common purpose. Three persons at least were required for the constitution of a college, and the persons so associated were said to be incorporated. The term “*Society*” was also applied to them. They could hold property in common; they had a common chest; could sue or be sued by an officer representing the association; were governed by regulations made by themselves, if not inconsistent with the public law; and they existed as a college or society though the original members were all changed. A variety of other associations were known as colleges. Some were religious, such as the colleges of Priests, of Augurs, and of Vestal Virgins. Others were official, such as the colleges of the tribunes of the people, of

the questors, or of the decurions. A third class, known as "*Collegia Sodalitia*"—brotherhoods—were originally festive, maintained for purposes of friendly association, like modern clubs, but afterwards became political. Among the colleges for trade were those of the "*Fabri*" or handicraftsmen, workers in wood, stone, metal, and other materials; "*Pistores*," including millers, bakers, and pastry-cooks; "*Nariculares*," including owners and masters of ships and boats.

The Greeks also had similar associations, called "*Eranoi*," which seem to have more nearly resembled the medieval guilds than even the colleges of Rome did. Women as well as men were members of these associations. The members contributed to a general fund; they had regular meetings for deliberating on their affairs, for feasting, and for celebrating religious rites; they assisted each other when assistance was needed; and provided for the funerals of members who died in poverty. Failure to make the prescribed payments to the association, except in cases of poverty and sickness, was visited by expulsion. Disorderly conduct at the meetings was punished by fine. In Greece also, as in Rome, these societies concerned themselves with religion, with commerce, and with political life.

In truth, the colleges of Rome and the *eranoi* of Greece equally gave expression to a tendency of human nature to seek in association the means of promoting the enjoyment or the advantage of their members. In this respect they had so much in common with medieval guilds, that many have sought to connect these guilds with the Roman *collegia* as they existed throughout the cities and provinces of the Empire. The preponderance of opinion, however, seems to favour the theory that the true origin of these guilds is to be found in the habits and institutions of the strong Northern races to which the Empire succumbed.

Accepting this view, the question arises, in what habits or institutions of these races are the origins of medieval guilds to be found?

Among the Northern races feasting held a prominent place. Births, marriages, and deaths, and all the more important incidents of family life, were made the occasion of banquets. Coronations, meetings of the National Assemblies, alliances, and other great events of State were celebrated by feasts. Religious festivals were similarly accompanied both in Pagan and Christian times, and every freeman was required to attend them, providing his own

share of food and drink. These feasts were known as *guilds*, and some writers have sought to find in them the origin of the guilds of later times. But Wilda, the principal writer on the subject, disputes this theory. He recognises the resemblance between them as regards the custom of banqueting ; but of the essence of the medieval guild—"the brotherly binding together in close union, which expressed itself in manifold ways, in the mutual rendering of help and support"—he finds no trace in the banquettings of the family or the feastings at State or religious ceremonials.

The theory which finds most acceptance in the present day is that in which the medieval guild is regarded as an expression of the same practical tendency of the old Northern races, which took form in the *frith-borh* of the Anglo-Saxons. The *frith-borh* was an association within a particular district, in which each member joined in the *borh* or pledge that the peace should be kept, and certain public duties be performed by all the others. The guild was an association for common objects of private and individual benefit, in which each member gave his pledge to obey the laws of the society. The two ran thus, so to speak, side by side, and there is little room for surprise to find them sometimes intermingling. In the laws of King Alfred (A.D. 891-901) there is a provision to the effect that if a man without paternal relatives fought and slew another, his maternal relatives had to pay a third of the *were*, i.e., the price or value of the man's life ; his guild brethren a third part ; "for a third," say the laws, "let him flee." If he had no maternal relatives, then his guild were required to pay a half of the *were* ; for the other half, the laws said "let him flee." The following section enacted that if a man without relatives was slain, the *were* had to be paid by the slayer—one-half to the king and the other half to the guild brethren of the slaughtered man. A later document, of the time of King Athelstan (A.D. 920-940), refers to a *frith-guild* in which the public objects of the *frith-borh* are associated with the private and individual objects of the guild. This document, called the *Judicia Civitatis Lundonice*—Dooms of the City of London—bears to be an ordinance of the bishops and reeves of that city, confirmed by the pledges of the brethren, for the government of a guild, partly religious and partly secular in its objects. Among the former, provision was made for a monthly meeting for the transaction of business and butt-filling—the filling of butts or vats. At each meeting a refection was provided, and

whatever was left was bestowed in alms "for the love of God." What is meant by the words "butt-filling" is uncertain. It had reference, doubtless, to the brewing of ale, but whether the ale so brewed was drunk by the brethren at their meetings, or was sold for the benefit of the guild, does not appear. We know, as regards other guilds of a later date, that they brewed ale which was drunk by the members at their meetings. The Abbot of Battle was a member of four guilds, to each of which he contributed for the brewing of ale, but his share of the drinking was done by deputy—a poor man represented him at each meeting to perform this duty. Still more directly in the nature of a religious duty is the requirement that, whenever a brother of the guild died, each member should give a loaf for the soul of the departed, and also sing, or get sung, fifty psalms within thirty days. The other secular articles of this code have relation to the detection and slaughter of thieves, and the protection of the life and property of the brethren. Every member was required to contribute fourpence for the common purposes within twelve months, and one shilling towards defraying the cost of pursuing thieves. The guild was divided into sections of ten members, one of whom—the head man—was required to direct the nine in their several duties; these sections again were grouped in tens under a "*hyndeman*," or common leader, who, with the head man of each of the decennial sections, acted as treasurers and advisers of the hundred,—deciding what should be disbursed when aught was to be paid, and what should be received when money became payable to the guild.*

Three Guild statutes of the beginning of the eleventh century furnish the oldest and most complete accounts of guilds in Europe. These statutes have reference to Orcy's guild at Abbotsbury, to the Guild at Exeter, and the Guild of Thegns at Cambridge. The founder of the first—Orcy—was a friend of Canute, and he endowed it with a guild-hall to the honour of God and St. Peter. The guild seems to have consisted of two classes of members—full guild-brethren, and members who were not full guild-brethren. All the members had to make specified contributions in money or wax, in bread well boulted and thoroughly

* An imperfect Canterbury charter of the reign of Ethelbert (860-866), refers to a guild as attestors. If the charter and reference are genuine, Dr. Stubbs remarks, "it is the earliest extant instance of such a Guild in England."

baked—towards the common alms—in wheat and in wood. But members who were not full guild-brethren had to contribute twice the quantity of wood which full guild-brothers had to provide, and, failing wood, an equivalent in corn. The wax was for lights in the Minster. There was a common meal to which each guild-brother could apparently introduce one or more guests. Fines were prescribed for failure to perform duty, for using offensive language, and for bringing more guests to the guild feasts than the prescribed number. The only duty which these statutes prescribed was attention to the comfort of the sick and dying, attendance at the funeral of deceased members, and prayers for their souls.

The statutes of the guild at Exeter appointed three meetings to be held annually, and required each guild-brother to have two *sesters*, or firkins, of malt, and each *cniht*, or young man, one *sester* and a *sceat* of honey. Here, too, it will be noticed, there is a reference to two classes of members—the guild-brother and the *cniht*. The word *cniht* may no doubt mean a servant, but more probably represented a young freeman, who, though not a full citizen, and therefore not reckoned full *gelyldan*—full guild-brother—was, nevertheless, connected with the guild. In this Exeter guild the association for purposes of worship and prayer stands out more prominently than in the Abbotsbury guild. Thrice-a-year the members met for religious services. At these meetings, which also seem to have been followed by a common meal, masses and psalms were appointed to be sung by the priest, and by the members, for the living and the dead. On the death of a brother masses or psalms were also appointed to be sung, and each member had to contribute fivepence. At a house-burning each had to contribute one penny. Neglect to attend the prescribed meetings and the use of offensive language were punished by fines. There is no provision in these statutes, or in those of Abbotsbury, as there is in the London Dooms, connected with matters of law or police. Both relate exclusively to religious duties. The statutes of the guild at Cambridge contain much more. Not only do they provide for the burial of members, the punishment for misgreeting and violence, and the rendering of mutual assistance in times of difficulty or danger, but they enact that, if a brother be robbed, the guild shall exact eight pounds from the thief; if a brother slay a man righteously, he shall be assisted by the guild to pay the *wergild*, if unrighteously then he must bear the penalty him-

self; if a comrade slay another comrade through his own folly, then he must not only satisfy the relatives of the slain, but buy back his brotherhood in the guild with eight pounds; if a guild-brother eat or drink with one who has slain a brother, save in the presence of the king, the bishop, or the ealderman, he must pay a pound, or clear himself by compurgation. It would seem that the guild must have been connected with the Corporation of Cambridge, as the enforcement of some of the statutes without the aid of the magistrates would have been difficult.

In these illustrations of early guilds—which may be considered typical—there were associations for festive purposes; for restraining rude and offensive language and action on the part of one brother towards another; for protecting the lives of the brethren by identifying the interests of the guild with those of each of its members, not only in bearing the penalty of manslaughter committed by him, but in exacting a share of the fine exigible in special circumstances when he was slain; for assisting the poor and sick; for maintaining the services of the Church; for providing masses and prayers on behalf of members who died, as well as for the living; and for attending the funerals of deceased members. All these were objects of a more or less private and personal character; but with some of them there were conjoined sometimes, as in the case of the London *frith-guild*, association for the maintenance of the public peace and the detection and punishment of crime. Some of these guilds, it has been seen, consisted of two classes of members—full guild-brethren, and persons who by reason of youth or other circumstances had not attained the full privilege of brotherhood. Women, too, it has been observed, participated in the benefits of these associations, though they had probably no share in the active administration of guild business.

Besides these objects which the guilds to which reference has been made were designed to promote, other guilds were established for a variety of religious and charitable objects. Among these objects may be mentioned the providing of lights to be placed on the altars, or before the images of patron saints; the celebration with befitting pomp and ceremony of Church festivals; the administration of relief to poor and sick persons; and the visitation and comforting of prisoners unconnected with the guild; the assistance of poor scholars; the maintenance of schools; and the payment of schoolmasters. In the Middle Ages, also, the representation of religious plays received the sanction and encouragement of the

Church. It was probably an effective means of teaching in an illiterate age; and guilds were established for the representation of religious plays, such as are still performed periodically at Oberammergau, in Southern Bavaria. Some guilds, again, were formed for the performance of secular plays. For the expenses connected with all these objects provision was made by the exaction of entrance fees and contributions, and by voluntary contributions and legacies.

Nor were such societies confined to laymen. Ecclesiastics were frequently members of guilds, sometimes to the entire exclusion of laymen; and sometimes, when laymen were admitted to the clerical guilds, they occupied a distinctly inferior position. These clerical guilds usually met on the first day of each month, and thus came to be known as "*Guilds of Kalenders.*" In some of these guilds the number of members was limited to twelve—the number of the apostles; in others to twenty-four; and the proportion of lay members, when such were admitted, was often fixed in a ratio proportioned to the number of clerical members. Thus, the guild of St. Canute, at Flensburg, was limited by its statutes of 1382 to twenty-four priests. When the prescribed number of clerics could not be obtained, the vacancies, to a number never exceeding eight, could be supplied by laics. Women were excluded from the meetings of this guild till 1422, when the ecclesiastical brethren yielded so far to the entreaties of their lay brothers as to admit their wives to the feasts held after the conclusion of the business meetings. This concession was, however, coupled with what appears to be the somewhat ungracious stipulation, that the wife of the brother whose turn it was to provide the meal should wait at the table. The mayor and his wife were appointed to have the first turn under this arrangement. When laymen were admitted to these clerical guilds they usually occupied a subordinate position, and were placed at a table separate from the priests, who seem to have conducted the business of the guild irrespective of the lay members. Not unfrequently the higher clergy constituted one guild and the lower clergy another. Almost every town had one of these *Guilds of Kalenders.* They were organised like other guilds, with a president, who was not inappropriately termed the "*Dean,*" Possibly the extension of this title to the head of mercantile and trading guilds may account for the peculiarity of the name which the head of the Merchants' Guild still retains. Guilds of

Kalenders had halls like other guilds, to which the members not unfrequently resorted daily "to beer and to wine." These clerical guilds were, however, rudely shaken by the Reformation in all Protestant countries, and though, in some parts of the Continent, these guilds still had occasional meetings for social purposes, they never resumed their former importance. The Guild of Kalenders at Bristol was one of this class.

More important, however, than any of these guilds were the guilds of merchants and craftsmen. The other guilds to which reference has been made were not necessarily connected with towns. The guilds of merchants and craftsmen were almost invariably urban institutions. But for the facilities which association afforded for merchandise, as well as for the protection which the trader received from his fellow-townsmen against what would otherwise have been the domination of kings or nobles, or the violence of robbers, commerce and manufacture would have been impossible. Many trading towns, also, were largely originated by foreign settlers, who drew around them those who could assist them in their business. Such aggregations of an industrial class created as well as met industrial requirements, and thus settlements which were originally often doubtless circumscribed in area and limited in population—like the trading factories of North America, Asia, and Africa in more recent times—developed into important towns. In such towns the merchant guild naturally took the most important position. There can, I think, also be little doubt that these guilds at first included what afterwards came to be known as the craftsmen. The craftsman of early times corresponded to the manufacturer of the present day. He purchased his hides, or his wool, or his wood, or whatever might be the commodity with which he worked; he employed—to a very limited extent, no doubt, as compared with present times—the hands he needed for the purposes of his business; and he supplied his manufactured articles, not only to his immediate townsmen, but to all and sundry who were disposed to purchase from him. Sometimes, also, he exported his goods, as well as imported the raw material from which he fashioned them. Carrying on such a business, he naturally took his place as a member of the merchant guild of the town in which he lived.

"In the most ancient charters from the Crown," says Mr. Thomas Thomson, one of the greatest of Scottish constitutional antiquaries, "the distinction between commerce or traffic, whether foreign or

"domestic, and manufacture or handicraft, is not very strongly marked ; nor are there any corresponding and well-defined distinctions between the classes of individuals entitled to these privileges." But in process of time a change was developed. At first the burgher—the essence of whose burgess-ship was the possession of heritable property in the burgh, for which he paid a mail or rent to the Crown or to the lord—was a member of a comparatively aristocratic class. He was a laird, with landed property not unfrequently outside of the burgh as well as within it. He frequently had commercial relations with other countries ; and on the Continent, as well as in England, and probably also in Scotland, the merchant who had made three long sea voyages became entitled to social rank. Gradually, as the burgesses acquired wealth and social importance, they assumed more and more the management of the town and the exclusiveness of caste. The simple hand-craftsman took his place on a lower platform than the merchant burgess. In course of time certain trades were regarded as beneath the dignity of merchandise, and every one who practised these trades with his own hand was excluded from the merchant guild. Thus the Burgh Laws enacted that no dyer, or flesher, or shoemaker—and, the Ayr MSS. added, no fisherman—should be within the freedom of the guild unless he swear not to practise his trade with his own hands, and only by means of his servants. This enactment indicates the progress of a tendency on the part of the mercantile classes to separate themselves from the craftsmen, and there can be little doubt that all over Europe they succeeded in doing so. The operative craftsmen, by reason of their separation from the merchant guild, lost the benefit of participation in guild privileges, and, among these, participation in the administration of the burgh, which gradually passed so entirely into the hands of the merchant guild, that in many towns the term "merchant guild" became synonymous with the word "burgh," and the hall of the guild synonymous with the "town hall." It must at the same time be remembered, however, that the word "guild" frequently meant nothing more than a payment, and that the term "guildhall" simply denoted, in early times, the hall of the burgesses of the town, in which hall they assembled and paid to the king or overlord the customs or dues exigible from them. So also, when, as in the case of Dover, it is said that a specified person held a piece of land in the burgh, "which was for the guild," the meaning is, *not* that the land or its profits belonged to

the merchant or other guild, *but* that it was applicable to the repayment of the guild or customs of the place. Of these guilds of merchants women might become members. The female members were, usually, wives or daughters of the guild-brothers, but in many cases women were admitted in their own right. In no case, apparently, did women participate in the administration or councils of the guild.

When these mercantile guilds were established in many towns of England and of the Continent does not appear. The first references to them are to existing and well established institutions. In the reign of Henry I. of England (1100-35) a merchant guild existed at York, and it was made the model of a similar guild at Beverley by Archbishop Thurstan in the year 1132. The practice of constituting a guild, or confirming one previously existing, with reference to the privileges possessed by a guild in some other town was common. In this way apparently the guilds of Winchester, Shrewsbury, Andover, Southampton, and Wallingford were confirmed by Henry II. (1154-1189); the guild of Gloucester was confirmed by Richard I. (1189-1199); the guilds of Helleston and Dunwich were confirmed by King John (1199-1216); and that of Hereford by Henry III. (1216-1272). In his reign also the guild of Chesterfield seems to have been founded. In many towns more than one mercantile guild appears to have existed at one time, but the inconvenience of this seems to have led to a union. The Dooms of London, to which reference has already been made, formed the code of what seems to have been a union of guilds formerly existing separately; and the Statutes of the guild at Berwick-upon-Tweed, which were accepted by all the burghs of Scotland, expressly set forth that what had previously been many guilds were united into one during the mayoralty of Robert Bernham in 1249. This code shows clearly that the merchant guild administered the affairs of the burgh, and exercised jurisdiction over the whole of the inhabitants—those who were *not* members of the guild, equally with those who were. With a view probably to such an absorption of the municipal government, and certainly as the only means of quietly attaining that object, an amalgamation of all the existing guilds in the burgh was effected, including, among others, a *frith guild*. The condition of matters thus indicated, as regards London and Berwick, also existed in the Low Countries, in Germany, in France, and in Scotland. The earliest records of Aberdeen and

Edinburgh, for example, refer to the guild as equivalent to the governing body of these towns. We are familiar in Scotland with a combination of burghs, whose laws, known as the "Laws of the Four Burghs," of Edinburgh, Roxburgh, Berwick, and Stirling, received legislative sanction as early as the reign of David I. (1124-1153), and afterwards became the laws of all the burghs of Scotland. That combination, which still survives in name, as the Convention of Burghs, had its counterpart in Northern Europe, where a Confederation of Guilds existed, whose general assemblies met at Skanör in Denmark. The famous Hanseatic Confederation, established in the thirteenth century, ultimately included eighty-five towns, and embraced every city of importance between Holland and Livonia. It was divided into four circles—the Vandal cities of the Baltic, the towns of Westphalia, the Rhineland, and Netherlands, the towns of Saxony and Brandenburg, and the towns of Prussia and Livonia. Lubec, Cologne, Brunswick, and Danzig were the capitals of these districts, and the edicts of the general diets were communicated to the masters of the great circles, who remitted them for execution to the merchant guilds within their respective jurisdictions.

How wide-reaching was the influence of this confederation is indicated by the fact that it had factories in London, Bruges, Novogorod, and Bergen, and that it was allied with Amsterdam, Antwerp, Bordeaux, Barcelona, Cadiz, Dordrecht, Leghorn, Lisbon, Marseilles, Messina, Naples, Ostend, Rotterdam, Rouen, Seville, and St. Malo.

How early mercantile guilds—in their more comprehensive sense of including craftsmen as well as merchants—were formed in Scotland, no means of ascertaining now exist. But a charter by William the Lion (1165-1214), preserved in the archives of Aberdeen, granted to all his burgesses of Aberdeen and Moravia (or Moray), and to all burgesses residing north of the Munth (or Grampian range), the right to have their free *Hanse*,* to be held when and where they chose, as freely, quietly, and fully as their

* A Hanse seems strictly to have been an association of *four*. There were four classes of towns in the great Hanseatic League. So the Four Burghs of Scotland consisted of Edinburgh, Stirling, Berwick, and Roxburgh, and when Berwick and Roxburgh fell into the hands of the English an Act of Parliament of David II. appointed Lanark and Linlithgow to take their places, and so to maintain the number of four. See also Robertson's "Scotland under her Early Kings," I., 298.

predecessors had enjoyed their *hansae* in the time of King David (1124-1153). This word *Hanse* seems identical with guild, and, like it, was sometimes employed to indicate a tax. It was known in England before it appeared in Germany or in Scotland. Reference has already been made to the merchant guilds of York and Beverley, in the reign of Henry I. (contemporaneous with Alexander I. and David I. of Scotland), and both towns had their *hansae-houses*, in which the common business of the burghers was transacted. William's charter then would seem to indicate that there existed in the north of Scotland, during his reign, confederations of merchants, burgesses of Aberdeen and of burghs north of the Grampians, whose privileges had been recognised and protected as early as the reign of David I. Then again, there is a charter by Alexander II. to Aberdeen, in which the burgesses are empowered to have a merchant guild—from which, however, fullers and weavers are excepted. Alexander reigned from 1214 to 1249, and this charter seems to confirm and ratify a body of merchants then existing, rather than to create a new body. But it does more; it excepts from the guild so recognised two important bodies of craftsmen—fullers and weavers; and it is difficult to believe that, when these were excluded from the merchant guild, others of less importance would be admitted.

The Acts of the Scottish Parliaments also afford continuous evidence of the efforts made from time to time by the powerful merchant guilds to monopolise privilege. Thus, a statute by James I. in 1457, followed by several others, prohibited the prosecution of foreign trade by merchants or others, who did not possess property of specified amounts. The object and effect of such legislation were obviously the maintenance of a practical monopoly of such trade by the richer merchants. In the reign of James III. again, in 1466, there is a prohibition against any persons sailing or passing in merchandise out of Scotland who are not freemen burgesses dwelling in burghs, "or their families, factors, or servants" who lodged with them. To this prohibition, however, an exception was made in favour of prelates, lords, barons, and clerks, who were continued in what would seem to have been a previously existing privilege, of exporting what was termed "their proper goods" by their servants, and of bringing home "things needful to their proper use." This reservation, in favour of what may be called the privileged class, was repeated in subsequent statutes. A

statute of the same parliament recognised and gave effect to the distinction between merchants and craftsmen, by prohibiting "every man of craft from using merchandise, by himself, his factors, or servants, unless he renounced his craft," without colour or dissimilation. This legislation was renewed in the end of the same reign by parliament ratifying an Act proposed by the commissioners of burghs, under which a craftsman using merchandise, without renouncing his craft, forfeited the merchandise. Legislation of this nature frequently occurred till the reign of Charles I. in 1633, when an Act was passed reciting and confirming the various previous statutes. These several statutes proceeded on the assumption that every member of the merchant guild was a burgess of the burgh, antecedent, and as an indispensable prerequisite, to being a member of the merchant guild. But these enactments, as applied for the exclusive benefit of royal burghs, were modified forty years later by the Act of 1672, which, while it retained for royal burghs the exclusive trade, in wholesale, of wine, wax, silks, spiceries, and dye stuffs, made the export trade of all native commodities free, and enumerated articles which might be freely imported. The Act gave a similar liberty to burghs of regality and barony, to deal with articles of their own manufacture, and completely freed the retail trade in all commodities. This statute introduced a large amount of legislation and negotiation as between the royal and free burghs and burghs of regality and barony, on which we may not enter, farther than to say that, in respect of the exclusive privileges of trade which royal and free burghs possessed from ancient times, they had to bear a certain proportion of public taxation from which unfree burghs were wholly exempted. When, therefore, the growing liberality of later legislation proposed to extend privileges of trade to unfree burghs, the royal and free burghs not unnaturally insisted that an extension of privilege should carry with it an extension of burden, and that, in respect of unfree burghs being allowed certain trade privileges which royal burghs formerly possessed exclusively, these unfree burghs should bear a corresponding share of the national burdens, to which royal burghs had formerly been subjected, in consideration of their exclusive privileges. The controversy went on for many long years till every one seems to have sickened of it, and ultimately, in modern times, all exclusive privileges of trade were abolished. The only thing which, in the present day, may revive the old controversy,

is the adjustment of the burghs' proportion of land tax, payable under the Act of Union with England. That tax is still leviable only from royal burghs, in respect of their ancient exclusive privileges of trade. Now that these privileges are abolished, the burden should either be removed or made applicable to burghs of every class, without distinction. Obviously burden as well as privilege should be concurrent.

But, just as the mercantile guilds became aristocratic and exclusive, and succeeded in shutting-out the craftsmen from participation in their privileges—including the management of the town's affairs—so the craftsmen were compelled, in self-defence, to draw closer to each other. In many cases, on the Continent and in England, they obtained charters and freedoms from the Crown, which, in its struggles with the nobles, or with the Church, or with the rich and powerful associations of merchant burgesses, found it to be the best policy to attach to it the subordinate orders of craftsmen, by giving them official recognition and privilege. The craftsmen, too, were not slow to perceive that in the alternating fortunes and necessities of contending parties and factions lay their opportunity to secure such recognition and privilege. Thus recognised and fortified, they were enabled successfully to assert their rights to a share of the town government. In many cases, especially on the Continent, they even eclipsed the merchant guilds, and practically monopolised the control of civic affairs. The twelve great Livery Companies of London are illustrations of this; but they illustrate also the tendency on the part of these craft guilds—after succeeding in securing their own privileges—to claim for themselves a monopoly of these, and to shut out their poorer brethren, who still held an inferior position with restricted rights. The richer craft companies of Florence seem to have followed a similar course of action. The earliest references to the craft companies of our Scottish towns show them to be in a position distinctly inferior to that of the merchant guilds. The oldest charters from the Crown to the burghs usually authorised the burgesses, who were of the merchant class, to have their merchant guild. The merchant guild assumed the government of the burgh, gradually dropped out the craftsman element, and became a very strict and exclusive oligarchy. What, in these circumstances, were the craftsmen to do? The craftsmen of each craft, doubtless, drew all the more closely to each other, and formed an unofficial bond of union in craft association. But to these associa-

tions no reference is made in the earliest records of Scottish burghs. All that is found there is reference to the fact that different kinds of craftsmen existed ; then it appears that the members of particular crafts had drawn up rules for their own government, and had applied to the council of the town to recognise and confirm these rules. This the council usually did, and the seal of the town was appended to the recognition. The recognition was regarded as a kind of charter of privilege, and in later times was not unfrequently confirmed by a charter from the Crown. Thus it is constantly said that such and such a craft had its seal of cause from the council of a particular date. But I believe these seals of cause are nothing more, in the great majority of cases, than a simple recognition and confirmation, by the council, of associations of craftsmen which had existed long previously, and many of whose members had been excluded from the merchant guild and all its privileges by a growing process of exclusiveness.

As regards the internal economy of these craft guilds, we find them very similar to the other guilds to which reference has been made. Each craft had its deacon and other officers ; it frequently founded or endowed a chapel or altar, with a priest to perform religious services, and it provided lights to be burned on the altar ; it prescribed the part to be taken by the craft in some of the great ceremonials of the church, and in the processions and masqueradings which were so popular in the Middle Ages and more recent times ; it provided mutual help to the members, assistance to those in distress, burial for the dead, and aid to the widows and children of departed brothers. It carefully provided for the maintenance of the customs of the craft, prescribing the conditions of admission to it, and the regulations according to which it was to be conducted. It set forth the means by which the character of the workmanship of its members should be maintained, and prescribed the punishments to be inflicted on all who violated these regulations.

This summary of the constitution and objects of craft guilds may be accepted as generally applicable to the guilds of the Continent and England, as well as to those of this country. But the former took prominence at a much earlier date than the latter. Craft guilds succeeded, on the Continent and in England, in obtaining a recognised position in the fourteenth and fifteenth centuries, when they frequently assumed an important share in

the government of the towns in which they existed, and sometimes wrested from the merchant guilds the exclusive administration of these towns. Foremost among these craft guilds were the weavers, who, in the early town communities, usually held an intermediate position between the patrician merchant class and the inferior classes of craftsmen—the latter being at an early period not unfrequently bondmen. In England, Flanders, and Brabant, as well as in the Rhenish towns, the oldest and richest crafts were the weavers. The weavers of Mayence existed in the eleventh century—those of Cologne, Spire, and Worms in the first half of the twelfth century. The weavers of London and Oxford received charters from Henry I. (1100-1134); those of Huntington, Lincoln, Nottingham, Winchester, and York received their charters from Henry II. (1154-1188). In Flanders and Brabant the weavers seem, from a very early period, to have practically led the other crafts in all their struggles for independence, and afterwards for supremacy. Probably, as the lower orders of craftsmen succeeded in raising themselves from the servile class or bondsmen, they formed themselves into guilds, modelled after the older guilds of the richer craftsmen; or it may be that they adopted, for the purposes of their craft guilds, the constitution and usages of the old religious guilds and frith guilds, to which reference has already been made. Thus associated, they may have long existed without recognition either by the crown or by the governing body of the towns—whether that governing body was the merchant guild or a body elected separately by the burghers. On the Continent the craft guilds had, but by no means invariably, the right to elect their own presidents, who seem to have been originally known as *aldermen*, and afterwards as *wardens* and *masters*. Sometimes the crown, and sometimes the superior of the town, who was not unfrequently the bishop of the diocese, excercised this right. But in England the craftsmen of each guild seem to have elected their own warden, so early as 1327-1371. Edward III. became a member of the linen armourers of London, and the royal example seems to have been frequently followed by other high personages connecting themselves by membership with craft guilds. It is impossible to enter here, however, even upon the most general sketch of the various orders of guilds of craftsmen, and all that I can venture to do now is to refer, in the shortest manner, to the legislation of the Scottish parliaments in regard to craftsmen, and to notice, in the briefest way, the

seals of cause and other official recognitions of craft guilds in three or four of our Scottish burghs.

A statute of the reign of James I., in 1424, evidently refers to a condition of circumstances in which the craftsmen of the Scottish burghs were formed into associations, for it required every craft in each town to choose one of its "wise men," with the consent of the officers of the town, to be deacon or masterman, to assay and govern all work done by the men of his craft (1424, c. 17). Three years later, however, the statute (1427, c. 4), declared that, previous ordinances in regard to deacons of crafts had tended to the common loss of the realm. Those statutes were therefore repealed, and the deacons then in office were appointed to exercise their functions no longer, nor to hold their meetings as formerly—these meetings "savouring of conspiracies." A few months later a council-general of the realm directed the town council of each burgh to elect a warden of every craft for one year, who, with advice of discreet men appointed by the town council, should examine and fix the price of all work. This ordinance was specially applied to masons, wrights, smiths, tailors, and weavers (1427, c. 3.) In 1457 an Act of James II. directed "an understanding and cunning man of good conscience" to be appointed dean of the craft of goldsmiths, to assay and stamp all gold and silver work (1457, c. 8). Sixteen years later, viz., in 1473, an Act of James III. appointed a warden and deacon of craft to be appointed in each town, in which goldsmiths were to examine all work coming from their hands (1473, c. 17). This Act was reaffirmed in 1485 (1485, c. 15), and again in 1489 (1489, c. 13). In 1493 an Act of James IV. set forth that deacons of crafts were dangerous, and might be the cause of great trouble, by making ordinances contrary to the common weal, and for their own profit. All deacons were therefore appointed to cease for a year from exercising any functions except examining the fineness of work, and seeing that it was wrought by craftsmen (1473, c. 14.) Three years later—viz., in 1496—an Act was passed in which—with the avowed object of remedying the great hurt and oppression through the exorbitant prices charged by craftsmen and workmen for their work—barons, provosts, and magistrates of burghs were empowered to set prices on victual, bread, ale, and other necessaries; examiners were ordered to be appointed to see these prices kept, and workmen taking exorbitant prices were appointed to be punished (1496, c. 5). In 1551 the magistrates of free burghs were ordained to

convene the deacons and craftsmen within their burghs, and to fix reasonable prices for each craft (1551, c. 18). Four years later the crafts in burghs were prohibited from electing deacons; their election, it being alleged, having conduced to the making of leagues within burghs, and between burgh and burgh. The council was required to appoint a visitor of each craft, to inspect the work of its members and to vote in the election of its officers; and no craftsman was to hold office in these burghs except two of the most honest and famous, who were to be chosen yearly on the council (1555, c. 26). Against this restriction of their ancient privileges the craftsmen seem to have appealed to Queen Mary, who, by a letter under the Great Seal, dated 16th April, 1556, restored to the crafts the power of electing their own deacons, who should have power to vote in the election of the officers of burgh, and also the power of making ordinances for their own government and the maintenance of divine service at their altars. Her Majesty further confirmed to the craftsmen all their former rights and privileges. Eight years later—viz., in March, 1564—the Queen granted another letter to the craftsmen of Scotland, under the Great Seal, by which she gave them dispensation from the provisions of the Act of Parliament of 1555, and confirmed all their previous rights and privileges. A similar dispensation from the operation of the Act of 1555 was granted by King James on 22nd July, 1581, in a charter to the craftsmen registered in the Great Seal Register. This charter, as well as the letters from the Queen, expressly state that the Act of 1555 had tended to increase rather than diminish the evils which it was intended to remedy. In 1584 the differences between the merchants and craftsmen of Edinburgh were settled by a decree arbitral, in which King James acted as oversman, and which united the craftsmen with the merchants, giving the former a voice in the election of magistrates, in the management of the property and patronage, and in voting extents and contributions. But the craftsmen were not to make statutes for themselves without confirmation by the magistrates. The disputes between the merchants and craftsmen of Glasgow in regard to their mutual rights and privileges were, in like manner, settled by arbitration, and the decree arbitral was ratified by Parliament in 1672.

Turning now, and in conclusion, to the references which occur in the records of some of the oldest Scottish burghs to various descriptions of craftsmen, and passing over an alleged charter by

Malcolm III. to the masons of Glasgow in 1057, I find references in the records of Aberdeen, so early as 1442, to dyers, smiths and hammermen, tailors, skinners, weavers and walkers, cordiners, and fleschers. In 1449 the council of that burgh approved of a deacon selected by the weavers; and in the same year the council of Edinburgh granted a seal of cause to the cordiners. In 1450-1 the skinners of Edinburgh are mentioned in the records, and in 1456 or 1466 the craft of bakers is referred to. In 1458 the records of Aberdeen allude to eleven public bakers as exercising their trade in that town, each having a distinguishing mark. In 1460 the council of Glasgow confirmed regulations for the cordiners and bakers of the city. The council records of Edinburgh show that in 1473 the hatters and bonnetmakers, in 1474 the skinners, in 1475 the wrights and masons and also the weavers, in 1479 the cordiners, and in 1483 the hammermen, each received seals of cause from the council. The craft of hammermen, it may be observed, seems at this time to have included blacksmiths, goldsmiths, lorimers, saddlers, cutlers, bucklers or armourers, and pewterers. Several of them, however, afterwards seem to have received seals of cause as separate bodies. In 1484 the council of Aberdeen ordered tailors and all other craftsmen to bear the tokens of their crafts on their breasts and to appear in their best array at the offering on Candlemas day. In 1488 the fleschers of Edinburgh obtained a seal of cause from the council, in which reference was made to a deacon and principal master of that craft. In 1489 the coopers of Edinburgh were added by the council to the wrights, who had obtained a seal of cause in 1475. In 1496 the craftsmen of Aberdeen were ordered to make a standard for their crafts. In 1500 the council of Edinburgh granted seals of cause to the waukers and tailors, and in 1505 to the surgeons and barbers,—which latter seal of cause was confirmed by James IV. in the following year. In the same year (1505) the records of Aberdeen set forth the ancient custom of the craftsmen of that town to walk in procession on Candlemas day, in their best array, and prescribed the future order of their procession and the furnishings which each craft was to make for the play which was performed on that occasion. Two years later there was an order by the council of the same burgh that the skinners should precede the cordiners in all processions. In 1508 the craftsmen of Edinburgh asserted a claim to be on the council of the burgh. In 1509-10 the

cordiners of Edinburgh received another seal of cause. In 1511 the council of Aberdeen authorised the tailors to choose a deacon. In 1512 each of the crafts of Aberdeen was ordered to have a pair of torches on Corpus Christi Day, i.e., the Thursday after Trinity Sunday—Trinity Sunday being the next Sunday after Whitsunday. In 1512 the weavers of Dundee obtained a seal of cause from the council, which, in 1516, gave the glovers their seal of cause. In 1516, also, the council of Glasgow, with the consent of the archbishop, granted a seal of cause to the skinners and furriers. In 1517 the council of Edinburgh granted a seal of cause to the candle makers. In 1519 the council of Aberdeen granted a seal of cause to the hammermen, and in the following year confirmed the election by the shoemakers of the deacons and officers of that craft. In 1520-1 the council of Edinburgh granted a seal of cause to the weavers. In 1525 the dyers of Dundee obtained a seal of cause from the council. In 1527 the council of Aberdeen granted a seal of cause to the wrights, coopers, and masons; and in 1528 the council of Glasgow, with consent of the archbishop, granted a seal of cause to the weavers. In 1530 the council of Edinburgh granted a seal of cause to the bonnetmakers; and the council of Aberdeen ordered each craftsman to be provided with weapons, and to wear them. In the following year the tailors of Edinburgh obtained a seal of cause, which was confirmed by James V. In 1532 the council of Aberdeen fined the bakers of that town for failing to report, and to obtain approval of, the person whom they had chosen to be deacon; and, in the same year, they granted seals of cause to the hammermen and to the tailors; and sanctioned an election by the weavers of a deacon of their craft. In 1533 the council of the same town appear to have granted another seal of cause to the tailors; and the council of Edinburgh granted one to the skinners and furriers. In 1536 the council of Edinburgh granted a seal of cause to the cordiners. In the same year the weavers of Aberdeen endeavoured to assert independence of the council, but the attempt was resented and punished by the magistrates. In 1536 the council of Glasgow, with the consent of the archbishop, granted a seal of cause to the hammermen; and in 1537 the barbers of Aberdeen received a seal of cause from the council. In 1546 the council of Glasgow, with consent of the archbishop, granted a seal of cause to the tailors, and in the same year Queen Mary confirmed that seal of cause.

In 1551 the council of Glasgow confirmed regulations for the masons of the town. In 1553 the cordiners of Edinburgh received a seal of cause from the council. Some years later the crafts of Aberdeen asserted a claim to participate in the management of the affairs of the town. In 1558 the council of Glasgow, with consent of the Archbishop, confirmed in favour of the cordiners the regulations of 1460. In 1565 the crafts of Aberdeen, encouraged no doubt by the support of Queen Mary, followed up their claims as previously made, by entering into a combination to obtain a share in the town's management. In these circumstances the magistrates appealed to the Queen, who wrote the craftsmen a letter requiring their submission to the magistrates. In 1569 the council of Glasgow granted seals of cause to each of the coopers and cordiners, and in 1570 confirmed to the hammermen their seal of cause of 1536. In 1580 they granted a seal of cause to the fleschers. In 1581 the goldsmiths of Edinburgh obtained a separate seal of cause from the magistrates, who in 1584 granted another seal of cause to the tailors. In 1586 the skinners, as well as the cordiners of Edinburgh, each received a seal of cause from the council. In 1587 the disputes between the guild-brethren and craftsmen of Aberdeen were settled by a decree-arbitral from which it appears that a deacon-convener or head of the associated crafts existed in the town at that time. In 1593 the council of Edinburgh recognised the furriers as a craft. The seals of cause granted by the councils of Edinburgh and Aberdeen after this date seem to have been mainly designed either to confirm grants previously made or to give separate constitutions to particular crafts which had previously been associated with others. The seals of cause granted by the council of Glasgow, to which reference has been made, proceeded, it will have been observed, with the consent of the Bishop or Archbishop, who was the superior of the burgh—which was a burgh first of barony and afterwards of regality, but was raised by James VI. in 1611 to the rank of a royal burgh. The seals of cause by the council of Glasgow to the craftsmen, subsequent to 1597, of which I have note, are as follows:—one to the dyers and bonnet makers in 1597, one to the wrights in 1600, a ratification in the same year by the council of an act of the deacon-convener's house in favour of the cordiners, a seal of cause to the weavers in 1605, one to the surgeons and barbers in 1656, a confirmation in 1676 of the seal of cause to the hammermen granted in 1536, a

seal of cause to the gardeners in 1690, a confirmation in 1693 of a seal of cause to the hammermen granted in 1536. Besides these seals of cause, various crafts obtained confirmations by the Sovereign and by Parliament of their rights, but to them it is unnecessary for my present purpose to refer.

The confirmations thus given by the town councils of Edinburgh, Aberdeen, Dundee, and Glasgow to the guilds or associations of craftsmen in these towns may be accepted as fairly illustrating the practice in the burghs of Scotland. It is of course impossible here to refer to the special terms of these official recognitions. They are not in all cases the same. In some—to use the words of Mr. Thomas Thomson in the General Report on Municipal Corporations in Scotland in 1835—“there is an express prohibition of all persons from working who are not freemen of the craft; and in others the right consists in a delegation to the craft, of the privilege of admitting new members, inspecting commodities, making bye-laws, electing office-bearers, and having a box or common good. In all of them there was, of course, implied a strict monopoly within the limits or freedom of the burgh as existing at the date of the grant, but not further, even when the limits of the royalty have been subsequently enlarged.”

In this hasty and very imperfect sketch, I have endeavoured to indicate, in merest outline, the general character of the guilds of ancient, mediæval, and modern times—for all of them seem to rest upon common tendencies of human nature, moulded, no doubt, by special requirements and the habits and institutions of the peoples amongst whom they were established. So far as these guilds were simply religious, or festive, they call for no further remark here. In so far as they were established for the prosecution and maintenance of mercantile or craft privileges, they no doubt served a beneficial purpose by securing protection and the opportunity of development to interests which would otherwise have been overborne. In the progress of civilisation these guilds have each and all, no doubt, done good service; but, having done that, their tendencies were to aggrandise themselves, and so to become mischievous. The time came, therefore, when they had to be restrained and subordinated to institutions of freer and less exclusive character. Mercantile and craft privileges have, in consequence, largely disappeared, and the incorporations which formerly possessed them are now mainly benevolent associations, engaged in the administration, for laudable

objects, of the property and revenues which have descended to their present administrators. Let us not forget, however, that these institutions are links in the chain which bind the present to the past ; and, with reference to them, as to all others, we shall best understand that which *is* by learning to know that which *has been*, and the progressive steps by which the institutions of the present day have been evolved out of those of past times. Narrow and exclusive the old merchant and craft guilds undoubtedly were, but they recognised and proclaimed the obligations which each brother and sister underlay to all the others ; they recognised common religious obligations, and provided for common religious service ; they emphasized the claims of brotherhood, and provided mutual assistance and sympathy in times of need, relief to the poor and destitute, burial to the dead, and support to the bereaved ; they prescribed standards of effective workmanship, and charged themselves with the training of those who were to carry on the business of the craft. In so far as they did all this they did good and commendable work. Their illiberal, intolerant, and exclusive action towards others was very much the reflection and almost inevitable outcome of the times in which they existed. But, as regards the old mercantile and craft guilds generally, we may surely say, that the good they did still lives and we inherit it. The evil has largely passed away, and the story equally of what they did well and unwisely remains to stimulate and to warn those who come after them.

Note.—In compliance with a desire of the Council, there is appended a list of authorities to which reference has been made in the preparation of the above paper :—

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XIV.—*Note on the Australian Aborigines being exhibited in Glasgow in March, 1886.* By JOHN GLAISTER, M.D., F.F.P.S.G., &c., Lecturer on Medical Jurisprudence and Public Health, Royal Infirmary School of Medicine.

[Read before the Society, 3rd March, 1886.]

THE *Physical Characters* of the native inhabitants of Australia, Tasmania, and the islands in immediate proximity, form a distinct group, having certain differentiating peculiarities, but also having certain affinities to other races.

They have high dolichocephalic (*i.e.*, elongated from before backwards), prognathous (*i.e.*, where the upper jaw is visible by looking perpendicularly down upon the skull), and phanerozygomatic skulls, with an index of breadth 71, and an index of height 73.

The nose is narrow at the root, and is very wide at its front part, but is not curved like the Papuan nose. The nostrils are widely expanded. The mouth is large and unshapely, and the lips are thick. The third upper molar tooth has three roots—a rare thing among Europeans. The hair of the head is long, inclined to curl, and forms a mass upon the top not unlike a crown. In certain parts of Australia—in the peninsula of Coburg—the hair of the head is straight, as is also that of the Mount Shadwell tribe. Mr. E. Palmer, indeed, says that generally in the northern tribes, the hair is mostly straight, with an inclination, when clean, to wave; and that the men are bearded. This straightening has been attributed to intermixture with Malay tribes, but this has been doubted by other observers.

The colour of the skin is always dark; it may be quite black, or it may be copper-coloured. The aborigines who are now presented are perfectly black; they are Queenslanders. But even in these tribes the colour varies. For instance, on the river Cloncurry, in Queensland, Palmer relates that he saw some reddish-brown in colour.

The nearest in appearance to the Australians and Tasmanians are the Papuans.

Bodily Stature.—At King George's Sound (south-west corner of Australia) we meet with the worst specimens, but the type improves as we go northward and eastward.

In the north-east limit of South Australia some of the best type are to be found (M'Kinlay). On the Thomson River in Queensland, far from the coast, fine and powerful men are to be found; so also on the shores of Queensland, strong-limbed and well-built men are to be found.

The Northern Queenslanders are straight, well-grown, and strong; and the women are noted for their height, being hardy and capable of much endurance.

In the specimens presented to the Society—being from Queensland—the following are the leading physical features:—

All have wavy black hair on the head, forming a shaggy crown; a chocolate-coloured skin; high forehead, but of ordinary size; a nose which is larger than high, the root sloping much, and the nostrils widely-dilated transversely; brown eyes, with yellowish-tinted sclerotics. The face is of average size. The mouth is very large, the lips are thick, and the chin retreats. The hair on the face of the man (Billy) is thinly scattered. The bust is short, and supports the upper and thin limbs. The feet and hands are small, but look large because of the very graceful extremities of the limbs. The colour of the skin differs in different parts of the body in the male, but in the woman the different parts bear the same colour—face, trunk of body, and limbs. The palms of the hands and the soles of the feet are much lighter in hue.

This regularity in tint in the female—an observation which has also been made by different authors—is said to be due to the fact that the female preserves most strongly the characters of the ancestor.

The colour of the raised cicatrices resulting from tattooing vary also in tint.

MM. Drs. Houzé and Jacques of Brussels have noted a special odour exhaled from the body of these people, so strongly in the case of some of them as to make the observers think of the smell of the he-goat.

One of the features of these people to which I would like to call attention is that of the presence of raised *scars* on the body. These are to be found on the bodies of the man and woman, not, of course, on the boy, because he had not attained the age when he should be initiated into the mysteries of his tribe.

These marks are made generally upon the chest, the back, the deltoid region, and the upper part of the abdomen.

Varieties in the form of the scar-markings indicate tribal differences.

On the deltoid region are to be found a series of descending parallel lines, numbering six or seven, and 10 to 12 centimetres in length. The man has on each side of the chest a curved line, with its concavity turned towards the exterior, beginning on a level with the lower part of the sternum, and terminating above about the middle part of the clavicle. There are also to be seen a series of transverse parallel lines, about 18 to 20 centimetres long, extending from about two fingers' length above the umbilicus down to the xyphoid appendage of the sternum. There are other markings on the man.

On the woman, beside the deltoid markings are to be also found a series of small notches, obliquely made two-and-two, coming from the lowest point of each deltoid marking.

All authors on this subject agree as to the universality of these marks.*

Another peculiarity of the man is the ornament which he wears poised in the septum of the nose. This is simply ornamental.

To return to the *scars*. The chief noteworthy peculiarity of these is their being *raised—thrown into relief*.

We know that a scar ordinarily is depressed, by reason of the normal structure of the skin being lost and replaced by another and simpler structure, scar-tissue, which shrinks as it becomes older. Now, why should the scars be raised? Why should they be thrown into relief?

Let us see how they are produced. They are made either with sharp flints, the sharpened edge of a shell, or the edge of a glass bottle.

* Palmer tells that "most of the Gulf (of Carpentaria) natives mark themselves with raised cuts, across the chest and upper arm, made with flints at various times while young. These cuts are merely ornamental, and convey no idea of tribal connection. All were more or less marked, and some of the bands of raised flesh were firm and hard like strong cords. One gin, I observed, had three rows of double cicatrices down her back, composed of eight couplets in each row. The middle row across her spine was smaller than the two outer. The scars were very regular, and the rows set off a very graceful figure. Besides these she had several longer bands across her hips, below the small of the back; others on the upper arm, and bands of raised marks between her breasts." (*Journal Anthropol. Instit., London*, Vol. XIII., 1884, p. 286.)

When the lacerations are made, they are either stuffed with clay, and so prevented from healing quickly, or, as Dawson says—"The operator cuts through the skin with a flint-knife, and rubs the wound with green grass. This irritates the flesh, and causes it to rise above the skin. By repeated rubbings, the flesh rises permanently, and the wounds are allowed to heal." *

Then, as to the *nose ornament*. When they come of age the nasal septum is pierced "with the pointed bone of the hind leg of the Kangaroo, which is pushed through, and left for a week. A short tube, made of the large wing-bone of the swan, is then introduced to keep the hole open, and is turned round occasionally, while the nose is kept moist by holding the face over a vapour bath, produced by pouring water over hot stones. When the wound is quite healed, the ring is removed. On occasions of ceremony, a reed about 18 inches long is pushed through the opening, and worn as an ornament." (*Op. cit. loc. cit.*)

Says Forrest (*loc. cit.*):—"Boring their noses is quite a ceremony with them, and once a-year hundreds gather together in order to bore the noses of the younger men, and also to cut one another's hair."

The ears are never bored.

MEASUREMENTS OF PRINCIPAL PARTS OF SPECIMENS SHOWN.

BILLY. MM.	JENNY. MM.	LITTLE TOBY. MM.
Length of Nose, 41	38	38
Breadth , , 41	41	37
Length of Nostril, 7	8	6
Breadth , , 12	11	10
Cephalic Index, 70·46	71·12	75·42
Height, - 1510=59½ in.	1560=61½ in.	1220=48 in.
Length of Foot, 230=9 in.	215=8½ in.	181=7 in.
Weight, 44 k 550=98½ lbs. 49 k 100=109½ lbs. 21 k 200=47 lbs. nearly.		
Total Length { 583=23 in.	574·8=22½ in.	438=17½ in.

* Forrest states that "Tattooing and marking themselves on the shoulder, back, and breast are very common, indeed almost universal amongst them." (*Journal, op. cit., vol. V., 1875, p. 317.*)

Dawson also states that "Both men and women are ornamented with cicatrices—which are made when they come of age—on the chest, back, and upper part of the arm, but never on the neck or face. These cicatrices are of a darker hue than the skin, and vary in length from half an inch to an inch. They are arranged in lines and figures according to the taste or custom of the tribe." ("Australian Aborigines," p. 82.)

Besides these permanent body-markings, they have temporary ones painted on the surface, and these vary in colour and position in respect to the nature of the occasion.

In their "Korroborees" or dances, they are painted with pigments. Some have white bands across the body, some down the legs; or, the markings may be in spots.

Dawson says "they paint their bodies and limbs with white stripes, in such a manner as to give them the appearance of human skeletons."

In their amusements the chief actors are painted differently; the "chipperuiks," or clowns, being elaborately and ludicrously pigmented. When a messenger is sent to another tribe to apprise them of the death of his chief, his head and face is covered with white clay; and a bridegroom is painted with a white streak over and under the eyes, and red lines beneath them; the bride similarly.

Their *Marriage Laws* are very interesting and, to us, peculiar; the sole and whole object of them being to prevent union between those of one flesh.

They are divided into tribes. Every person belongs to his father's tribe, and cannot marry into it. Then again a provision is made to prevent marriage with *maternal* relatives.

This can be best explained by clearly following Dawson. He tells us that in the Western District there are five classes in all the tribes, which take their names from animals.

1. Kuurokeetch—the long-billed Cockatoo.
2. Kartpoerapp—the Pelican.
3. Kappatch—the banksian Cockatoo.
4. Kirtuuk—the Boa-snake.
5. Kuunamit—the Quail.

According to their classes they are distinguished as :—

Kuurokeetch, male ; Kuurokaheear, female.
 Kartpoerapp, male ; Kartpoerapp, female.
 Kappatch, male ; Kappaheear, female.
 Kirtuuk, male ; Kirtuukheear, female.
 Kuunamit, male ; Kuunamitheear, female.

No marriage is possible between 1 and 2, or between 3 and 4, because they are looked upon as sister classes; class 5, however, can marry into any class but its own. Thus a male of class 1 can marry a female of classes 3, 4, or 5, but cannot marry a female of classes 1 or 2; a male of class 3 may marry a female of classes

1, 2, or 5, but cannot marry a female of classes 3 or 4; a male of class 5 may marry a female of classes 1, 2, 3, or 4, but cannot marry a female of class 5.

Their laws also forbid a man marrying into his mother's or his grandmother's tribe, into an adjoining tribe, or into a tribe that speaks his own dialect. But a man may marry his brother's widow, or his deceased wife's sister, or one of her tribe; but not if he has divorced or killed his wife.

A common man may not have more than one wife, chiefs may have as many as they choose, while their sons may have two. Chiefs and their families may only marry into other chief families.

When a married man dies, his brother must marry his widow if she have a family, thereby differing only from the Mosaic law in this last particular.

Illegitimacy is rare; the woman receiving at the hands of her relatives severe punishment, or, perhaps, death. So likewise the father of the child. When a man has been permitted by the chiefs of each party to betroth himself to a woman, her mother and aunts must neither look at him or speak to him "from the time of his betrothal till his death." When they speak in one another's presence, they must converse in a different dialect, or "turn-tongue."

Young men are not allowed to marry till they have been formally initiated into manhood, which process is generally very severe, so much so, indeed, that sometimes it causes their death. This is thought to get rid of the weakly.

A man can divorce his wife for serious misconduct, and even kill her, but she cannot be divorced if she have borne children to him, although she may be punished. A wife cannot divorce a husband, even for unfaithfulness, but she may complain to the chief, who may order him punishment.

The father alone can give away a daughter; if he be dead, then the duty falls on the son, with the consent of his uncle. A husband and wife without family may dissolve their marriage, and both are free to marry again.

When a woman is near her confinement she must stay at home as much as possible. Should she leave her husband's wuurn, any one meeting her must leave the path. During the labour her husband must live elsewhere; not only so, but the neighbouring wuurns are deserted, and every one is sent away from the vicinity of her home, except two married women, who remain with

her. Nature is left alone to do her work, and the women rarely die in childbirth. When born, the infant is not black, but the colour appears within a short time after, appearing first on the brow, then extending over the body. Large families are not common; five being considered a large number. Every infant is suckled for about two years. Weakly or malformed children are destroyed.

Every person speaks the tribal language of the father, and cannot change it for any other, the exception only being the mother, who must speak to the child in the father's language and not her own. The consequence is that the wife speaks to the husband in the language of *her* father, and the husband to the wife in the language of *his* father; so that the conversation between them is as if an Englishman and French woman marrying were to speak to each other in their own tongue.

Cannibalism.—Oldfield, quoted by Wake, says that a man will, in case of extremity, kill his child to satisfy his hunger. The mother must not make loud lamentations over it, else she will be beaten, but she may utter inarticulate moans; these are, however, said to be assuaged by her getting the head of the child to eat, that part being her legal perquisite.

Palmer says that the killing of a new-born infant among the Queensland blacks is a matter of small moment. They express neither sorrow nor abhorrence at the deed. In North Queensland they make no secret of eating human bodies, not, however, as the New Zealanders or South Sea Islanders do. In the Gulf of Carpentaria only those killed in battle are eaten. The body is cooked in one piece, and the cooking is accomplished in three or four hours. When all the flesh is eaten, the bones are placed in a tree or burned. They eat only the bodies of those belonging to their own side, not those of their enemies.

Forrest says that cannibalism is also common among the natives of the interior. He says, "I myself have found a skull all charred at a native's fire." And he declares that they do not hesitate to eat the bodies of white people.

Dawson, at page 67 of his book, states that "there is not the slightest doubt that the eating of human flesh is practised by the aborigines, but only as a mark of affectionate respect, in solemn service of mourning for the dead. The flesh of enemies is never eaten, nor of members of other tribes." A body that has met its death by violence is alone eaten, not if mangled or unhealthy or

putrid. A child over four or five years, accidentally killed, is eaten by all the tribe except its brothers and sisters. "The flesh of a healthy, fat, young woman is considered the best; and the palms of the hands are considered the most delicate portions."

It must be borne in mind that the flesh of a body when divided among the many adult relatives only gives a very small portion to each.

Curious Laws are found, too, in operation among these people, the origin of which cannot be easily traced.

Circumcision is present in most of the tribes of Central and Western Australia, except in those in the south-west corner. It is a sort of religious ceremony with them (Palmer).

The law enacted in Leviticus xii. ver. 2-4 "is observed by all the tribes between Brisbane and Carpentaria with which I have come in contact during twelve years' sojourn in the country."—(Armit.)

Equally observed is the law obeyed as laid down in Leviticus xxv., ver. 19. In one instance, near Townsville, in 1870, a case was brought under the notice of the observer, Capt. W. E. Armit, F.L.S., where a Gin (woman) was put to death by her husband for having lain in his blanket during her menstrual period. His own superstitious dread of the consequent uncleanness killed him within a fortnight.

As has been before noticed, the law laid down in Deuteronomy xxv., ver. 5, is also carried out by these aborigines, but with this difference, that if man die and leave a widow and children, his brother must marry her and care for her and her children.

The ceremony of "Bora" or *initiation* into manhood is also accompanied by strange observances. In some tribes the youth has one of the incisor teeth knocked out by a chisel and mallet; in others there is produced deformity of the genital organs.

Their *Mental Characteristics*, as shown by Staniland Wake are as follows:—their ingenuity in overcoming difficulties is great, although their appliances are rude, as shown in their making of wells in loose sand to a depth of 14 or 15 feet, and about two feet in diameter at the bore; there are to be seen in different parts of Australia rude drawings and paintings. They display great ingenuity in some of their weapons, as, for instance, the boomerang, which is, however, to be found in other races. They present little of the phenomena of intellect; but the structure, complexity, forms of grammar, and copiousness of vocabulary of their language display great mental activity.

They steal, lie, are revengeful, cunning, jealous, and, as might be expected, courageous. Other observers give quite a different description of them, describing them as frank, open, and confiding. They betray little affection, and any sorrow they may experience is very transitory. This is well illustrated by the manner with which Billy received the news of his companion's death (with whom he had been closely associated for a long period). He was found enjoying himself by singing and beating his boomerangs when the news was broken to him, but he unconcernedly went on as before. They treat their wives very cruelly, they being made the slaves of the men.

In short, their intellectual capacity seems to be on a level with that of the child ; they know right and wrong, will not steal from another native, but will readily from a white man. They see nothing morally wrong in adultery, although the woman will be severely chastised by her female relatives. There seems to be a total absence of ideas of abstract morality, but they are full of superstitions, and believe in spirits. This last seems to point to a dim idea of a future existence. Dr. Lang says that they do not recognise a God, have no trace of a religion, and no idolatry.

The three natives who were shown to the Society are the remainder of seven, four having died from pulmonary disease. At the present time the boy suffers from incipient tubercular disease of the lungs. They exhibited to the Society their singing, and mode of fighting and throwing the boomerang. Their songs are all in the minor key.

BOOKS CONSULTED.

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- 2.—“Australian Aborigines.” James Dawson, 1881.
- 3.—“The Mental Characteristics of Primitive Man, as exemplified by the Australian Aborigines.” C. Staniland Wake, Esq., Dir. A.I. (*Journal Anthropol. Instit.*, vol. I., 1871, p. 74, *et seq.*)
- 4.—“Australian Languages,” by Rev. G. Taplin and Dr. Black; same volume, p. 84 and p. 89.
- 5.—“Customs of the Australian Aborigines.” Captain William E. Armit, F.L.S.
(*Journal Anthropol. Instit.*, vol. IX., 1880, p. 459.)

- 6.—“*Australian Marriage Laws,*” vol. IX., 1880, p. 354.
- 7.—“*Notes on some Australian Tribes,*” p. 276, by Edward Palmer, Esq.
,, “*on some Australian Beliefs,*” by A. W. Howitt, F.G.S., p. 185.
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(Journal Anthropol. Inst., vol. XIII., 1884.)
- 8.—“*On the Natives of Central and Western Australia,*” by John Forrest,
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- 9.—“*Les Australiens,*” by Drs. Houzé, et Victor Jacques. Bruxelles, 1885.
- 10.—“*Etude sur les races indigènes de l’Australie.*” Topinard. Paris, 1872.

XV.—*On Birds with Supernumerary Legs, and on Abcaudal Fission and Acephalus; with Biological Reflections.* By Professor CLELAND, M.D., LL.D., D.Sc., F.R.S.

[PLATES III., IV., V.]

[Read before the Society, 3rd February, 1886.]

THE occurrence of fowls with one or two appended limbs hanging between the legs on which they support themselves is well known. I had my attention first directed to it by specimens in the Anatomical Museum at Berlin many years ago. I have now four specimens of this abnormality beside me, all differing in detail, and, on comparing them, perceive that they have an interest not hitherto noticed, and that they demonstrate that the cases occurring in the human subject, described as exhibiting an appended undeveloped twin, have been habitually misinterpreted.

The first specimen (Fig. 2) to which I shall direct attention consists of a portion of the skeleton of a pheasant, and belongs to the anatomical collection of the University. It exhibits between the sacrum and the hinder part of the left ilium an angular interval, occupied by a diamond-shaped element, two inches in breadth, and nearly symmetrical, from which hangs an additional limb.

The diamond thus intruded forms one bone traversed transversely, as seen from behind, by the projecting inferior edge of its upper half, which is dorsally convex, while the inferior half, dorsally concave, exhibits, as seen from the ventral aspect, a superior margin thrown into two concavities, with a peak between; and opposite each there is a fossa between the upper and lower halves of the diamond, the right one perforated, the other not. The left of these concave margins lies side by side with a perfectly similar margin continued from the left ischium to the ilium, so as to complete the great sciatic foramen; while the one to the right, abutting against the left side of the sacrum, corresponds symmetrically with the margin completing the great sciatic foramen of the

right developed pelvic bone. The upper half of the diamond consists, therefore, of two iliac elements, and the lower consists of two ischial. So much is plain; but the question whether the additional pelvic elements are the right and left of one pelvis or the left of a right pelvis and the right of a left pelvis cannot be determined from this specimen alone.

From the middle of the diamond, under cover of the projecting line on its dorsal aspect, springs a single limb-bone of considerable length, attached by fibrous tissue, and femoral in character in the greater part of its extent, but towards its lower end showing trace of what seems to represent a tibio-femoral articulation. It terminates below in a bent and ankylosed tarso-metatarsal joint, from which a tarsal bone projects forwards to end in processes for three digits, which unfortunately have been lost.

The second specimen (Fig. 1) is a skeleton of a goose, likewise added to the University collection before my appointment. The additional pelvic elements are intruded on the right side of the sacrum, between it and the posterior part of the proper pelvic bone of the right side; but they are so thoroughly united with the proper pelvic bones that it is impossible to distinguish exactly their limits. However, there are two bars united in front and divergent toward the tail, and between these a smaller wedge-like element, pointed in front, and separated there by gaps from the bars between which it lies; and to the dorsum of this wedge at its point is attached a supernumerary limb.

As in the previous specimen, the proximal part of the limb is twisted, but obviously femoral; this is continued into a short and obscure tibial element, and beyond a more distinct ankylosed joint there is a well-developed metatarsal. This metatarsal is continued into three digits. The two lateral digits have each five phalanges traceable, though united by bony union. The intermediate has united to the extremity of its first phalanx two toes side by side, each with three other phalanges. Thus the lateral toes represent a right and left outer toe; and the bifurcated toe represents two third or middle toes, with a first phalanx in common. The dorsum of this composite foot is turned backwards, so that the part corresponding in structure with a left foot is toward the right side of the animal, and *vice-versa*.

The third specimen (Fig. 3) before me is a chicken not many weeks old, which I owe to the kindness of Mr. John M. Campbell. It has a pair of supernumerary legs, well developed, attached by

separate joints to the back of a pelvic structure very similar to the diamond-shaped plate of the pheasant already described, but fitting in more loosely between the right side of the sacrum and the right pelvic bone proper. As in that instance, so in this, the supernumerary pelvic structure has its ventral aspect turned to the ventral aspect of the bird; yet the two limbs which come off from it are, the one to the right a left limb, and the one to the left a right limb. As the bones are well developed, although the muscular surroundings are feeble, there is no difficulty in determining this. On examining the viscera of this bird, it is found that, while the intestine is single, there are two pairs of cæca all equally developed (Fig. 6). No other abnormality was observed.

The fourth specimen (Fig. 4) before me was reared by W. J. Shand Harvey, Esq., of Castle Semple, and presented to me through Mr. J. D. Dougall, of Gordon Street. It is a pheasant with a single supernumerary leg, but differs from the specimens already described, first in the pelvic bone of the supernumerary limb being quite disconnected from the pelvic bones proper, and secondly in the presence of two cloacal openings. The pelvic bone of the supernumerary limb may or may not have consisted of representations of bones of opposite sides; but the limb which is ankylosed to it is seen by its toes to belong to the left side. With the exception of the two distal phalanges of the middle one of the three forward toes, its joints are all obliterated; but five phalanges can be counted on the toe to the left, and the toe to the right consists manifestly of three, therefore the limb is a left limb. I observed no trace of the inner or hinder toe.

This pheasant presented the peculiarity additional to the possession of a supernumerary limb, that it had two cloacal apertures, each of about normal appearance, placed side by side (Fig. 5). They opened immediately into a single dilated cavity, and there was only one pair of ureters and kidneys. But it had three cæca, the mesial one in front of the single intestine. This contrasts with the chicken previously described, in as much as the chicken, though possessed of four cæca, could only boast a single cloaca.

It will be observed that in none of the four specimens of birds which I have now described have we had to do with an appended twin. They are all instances of longitudinal fission of the posterior end of the embryo, posterior dichotomy, or what I prefer to call abcaudal fission in contradistinction to acranial fission; and the developed limbs are in each case the right limb of the right

division of the embryo, and the left limb of the left division; while the adjacent halves of the two pelvises, with their respective limbs, have been dwarfed, and in different instances one of them has been suppressed, or the two, unable to get separate, have remained connate in a unity compacted from the blastema of both.

Abcaudal fission is known in the early condition of the chick; and I may illustrate by means of a specimen of a chick of thirty-six hours' hatching, in which two equally-developed vertebral columns diverge from one another behind a single heart (Fig. 7). Both divisions in such a case may continue to develop equally, producing an animal with one head and two bodies. But the peculiarity of all the abnormalities under consideration is that one of the divisions of the vertebral column disappeared altogether, while the two limbs normally developed belong, one to the division which is preserved and the other to the division which has entirely disappeared.

Instances are known of the development of a supernumerary composite limb in the human subject, on precisely similar principles to those on which such limbs are developed in birds. The best known is the case of Dos Santos, described in this country by Mr. Acton,* by Mr. Ernest Hart,† and by Dr. Handyside.‡ In that case the supernumerary limb had the knee turned backwards, and ended in a composite foot, with the great toes joined and the fifth toes to the sides. It was therefore not the fusion of two limbs belonging to one pelvis, but the fusion of the left limb of a right pelvis with the right limb of a left pelvis. This duplicity, involving the whole lower part of the body, was testified by the presence of two penises lying side by side between the two developed limbs, one for the pubis of each of two separate pelvises. The presence of an osseous element descending in the middle, so as to separate the pubic arch into two was detected by Mr. Hart and Dr. Handyside, and its nature correctly appreciated by Dr. Handyside. Mr. Hart also detected what seemed to have been a second anus which had become obliterated. Both right and left pelvis must have had their right and left walls respectively completed in front; but the adjacent walls of the two pelvises being pressed together by the further development of the

* *London Medico-Chirurgical Transactions*, xxix., p. 103.

† *Lancet*, July 29, 1865.

‡ *Edinburgh Medical Journal*, March, 1866. See also "Ahlfeld Missbildungen des Menschen." p. 98, and Plate XIX.

parts on each side which, on account of their connection with the column above, could not freely separate, obliteration had resulted, leaving a penis and imperfect pubic arch for each pelvis, while the lobes for the adjacent limbs had never been able to separate, but remaining conjoint at their superior or great-toe margins, formed the composite structure which hung from the perineum.

The case of Blanche Dumas as recited by Ahlfeld (page 89), is almost similar to that of Dos Santos, and seeing that its nature has been appreciated correctly, it is in the last degree surprising that the case of Dos Santos has been so thoroughly blundered.

Once, however, the case of Dos Santos is understood in the light thrown on it by the birds with supernumerary limbs, it follows that on the same principles are to be explained all instances of tumours over the sacrum with bones in them; such as Dr. Richardson's well known case, published by Sir James Simpson,* in which there was what might be called a tibio-femoral bone, imbedded in a ball of adipose tissue, and a single digit overhanging the tumour so formed; the cases figured by Vrolik,† and the numerous cases collected from Authors by Ahlfeld (Plates VII. and XIX.).

The difficulties attending any other explanation are insuperable. If in a partially divided embryo, one division grew more rapidly than the other so that the second, so far as surviving, became an appendage to the first, the place of junction would not be over the sacrum, but either on the ventral surface or within the abdominal cavity. If we adopt the old theory and suppose that embryos on two ova accidentally adhered, a possibility of union of the products of different ova is taken for granted, which really has nothing to support it. But indeed that theory is thoroughly disposed of by Von Baer, who alludes to it as the theory of Haller and Meckel.‡

Thus, I lay down the law that *in cases of supernumerary legs connected with the sacrum or perineum, the legs developed as the proper legs of the animal belong originally to two different pelvises, being the right limb of a left pelvis and left limb of a right pelvis,*

* *Medical Times and Gazette*, 2nd July, 1859.

† Vrolik, *Die Frucht van den Mensch en van Zoogdieren*, Tab. C.

‡ While these pages are passing through the press, Professor Virchow, in his *Archiv*, vol. ciii., p. 426, expresses regret that the number of writers who explain double-monstrosity by secondary agglomeration is again on the increase, and makes valuable strictures on the subject.

and that, in these circumstances the appended limbs may be two, or one of the two may be suppressed, or there may be a composite limb formed by the undivided blastema for two adjacent limbs of two pelvises.

In formulating this statement I am careful to limit it to supernumerary legs connected with the sacrum or perineum, on account of Von Baer's interesting case of a girl in which two supernumerary legs forming a pair hung over the pubis.* That case rather illustrates what I have said to the effect that in abcaudal fission, the result of one division growing more rapidly than the other would be to bring the place of junction of the blighted or appended parts round to the ventral aspect. In the cases which I have been explaining, the fission has not extended much beyond the site of origin of the pelvic limbs, and the rapid development of the externally situated limb of the aborted division of the embryo has no doubt been effective to unite its pelvic part to the vertebral region above the bifurcation, at so early a date as to crush out of existence its own division of the vertebral column, as well as to dwarf to a greater or less extent the two limbs placed in the middle. But in this case described by Von Baer, the dissection seems to show that the fission extended further, and the explanation of the arrangement of parts is similar to that which I applied years ago to limbs appended to the chest: namely, that, while there was evidence of fission having extended forward as far as the head, one trunk grew more rapidly than the other, and maintained its continuity with the skull, while the less developed trunk became stretched by its connection with the other and so destroyed; its remains being detected in certain cases as a thread going up to the base of the skull.† I suppose that in the case described by Von Baer the fission had not extended so far, but that in similar fashion, the upper portion of the less grown division of the double part of the embryo had been enclosed by the visceral walls of the other, while its lower portion, remaining outside was carried down by the visceral walls, at the expense of stretching and consequent destruction of the enclosed part.

Another instance of unequal development of the two divisions

* Von Baer, Doppelleibige Missgeburten. Trans. Imp. Acad., St. Petersburg, 1844, p. 79; "Beobachtung IX," Plates IX. and X.

† *Jour. Anat. and Phys.* May, 1874: "Double Monsters and Development of Tongue."

of an embryo which has undergone abcaudal fission is, to my mind, to be found in cases of completely separate acephalus. This I pointed out, in speaking of the destruction of structure by stretching in instances in which limbs are appended to the chest. I stated that "by far the most probable hypothesis to account for the production of completely separate acephali is that they have become, in process of early growth, detached by fissiparous division from the developed foetus which always accompanies such a monstrosity. An early rupture of the connexion with the head, and with the body of the perfect foetus, in the case of a completely separate acephalus, would give freedom for growth of the part separated."

That it is difficult, no doubt, to get full proof of this theory, may be frankly admitted. At the same time it may happen any day that an opportunity may occur of examining the body of a healthy twin, born along with an acephalus; and it is possible that, in its internal structure, trace may be found of organs, *e.g.*, lungs, originally belonging to the acephalus. It is easy to understand how, by a very slight change, including the development of an allantois and early rupture of the vitelline duct, the appended limbs of the girl forming the subject of Von Baer's Observation VIII. might have become completely separated and furnished with an independent cord. As for the theory of Claudius—according to which acardiac foetuses result from the weaker of two originally distinct embryos becoming afterwards united to the other and stronger by anastomoses of allantoic arteries, and consequently having its heart overpowered, the blood stagnating in it, and coagulation and atrophy resulting—it is praised by Förster for its sharp-sightedness, and has been taken up by Ahlfeld,* and is certainly highly ingenious, but is nearly incredible, both in respect of the effect on the embryonic heart imputed to reversed circulation, and in supposing total suppression of large part of the body to result from cutting off of the main channels of vascular supply at an extremely early date, when the formative powers are at their highest. Claudius, it appears, accounts for acormi by the same means. To my thinking, acormi result from abcranial fission, in which one of the two heads so developed is torn, in process of growth, separate from the undivided lower part of the vertebral column.

* Ahlfeld, *Missbildungen des Menschen*, page 47.

If anything further requires to be urged against the Cladus theory, it is to be found in the circumstance that it is quite inapplicable to acephalus included within the abdomen of its twin. One case of this sort is recorded and figured by Nathaniel Highmore—"Case of a foetus found in the abdomen of a young man, London, 1815"—and another is equally elaborately described by G. W. Young, in the Catalogue of Monsters, in the Museum of the College of Surgeons, London, series 1, sub-series 2, specimen 8. In the latter case, found in a boy 10 years old, we are informed that the cyst containing the enclosed acephalus had the pancreas of the containing abdomen stretched over it, a pretty obvious indication that the omphalo-mesenteric vessels of the complete embryo had dragged toward their origin the umbilical vesicle with the other embryo along with it, thereby probably effecting the separation thereof from the common head.

The story, then, of abcaudal fission in which one of the divisions or partially separated embryos outgrows the other seems to be this, that the connection of the parasite, or smaller division, with the vertebral column, is always destroyed by stretching; that the parts not enclosed by the visceral walls of the main embryo are left free to grow; that when the parasite forms external connections by means of an allantois of its own, its union with the main embryo becomes snapped across so as to give rise to a free acephalus, but that when this does not happen it remains appended. When remaining appended, the smaller division or so-called parasite may be attached at different levels mostly in the middle line in front in the sternal region. But I may add here, that to the same class belong those curious cases in which parts of a twin more or less complete escape apparently from the palate, but really from the base of the skull, the connection with the base being stretched by the development of the face.

To all such cases those which have formed the subject of description in these pages stand in broad contrast, because, though they result from a partial duplication by abcaudal fission, the unequal development which has happened in them is not an arrest of the right or left division, but an arrest of the adjacent sides of both divisions so far as the limbs are concerned, combined with disappearance of the right or left series of duplicated vertebrae.

Perhaps it may be well to note in connection with the subject of supernumerary legs that the composite character which they sometimes exhibit is not unknown in the case of the pectoral limbs.

It is well known that, in cases of double-bodied monsters with one head, sometimes a pectoral limb of composite character is found instead of two limbs on the adjacent sides of the bodies; but the only case which I have met with of a composite pectoral limb added to a superficially single thorax, is that described and figured by Tulpia, in which there were two heads, and one trunk, having, in addition to symmetrical arms and legs, a posterior arm ending in two hands with the thumbs adjacent, and a posterior leg similarly ending in a ten-toed foot.*

Bearings on Biological Questions.

The more one looks into the laws of such anomalous formations as we have been considering, the more difficult does it seem to reconcile them with our ordinary notions of individuality. There can be nothing more certain than that the mass of corpuscles destined normally to form a single embryo may, under some abnormal influence, break up into two, each of which inherits all the potentialities of the undivided mass, just as unicellular organisms produced by fission inherit the properties of the parent. The abnormal influence is possibly always external, and as Daresta has shown in the case of chicks, is often a change of temperature. Perhaps that may be the reason why the fission always proceeds from the surface to the deep parts. The fission may be complete, at least so far as the skeleton and parts more superficially developed are concerned, and yet the embryos afterwards become re-united by their adjacent sides joining to make one ventral middle line, and their more distant sides folding round and meeting in like manner to form another ventral middle line; and in this way, as is well known, a composite thorax is formed, or a composite head (*janiceps*) with two more or less complete faces looking different ways. But in the cases which we have been considering, the fission has never been complete, it has extended from the caudal end forward a greater or less way toward the head.

What I feel disposed to attract special attention to is that in the birds described and in every instance in which a human being is born with a sacral tumour containing vestiges of limbs however indistinct, as well as in a Dos Santos, or Blanche Dumas, there has been at an early date duplicity up as far as the base of the sacrum and including the lower limbs; that this duplicity so far as

* "Nicolaus Tulpia, *Observationes Medicæ*," Lib. iii, cap. 37. Copied also by Licetus in his work "*De Monstris*."

it extends is precisely the same thing as the duplicity of the lower limbs of the Siamese twins or any twins born with one set of membranes; and that, therefore, although in such cases the permanent limbs are indeed developed from those free sides of the embryo which would have existed normally, had it not been subjected to fissiparous division, yet it is equally true that they are limbs of two different pelvises, and in that sense not a pair. The sacral tumour may be so small as to be easily amputated, and for all we know, cases may occur in which the supernumerary parts are arrested even before the development of a visible tumour; yet in all of them, the historical peculiarity is the same.

The explanation may be sought in considering that the tendency to fission, possibly never wholly absent from an organism, is only made to show itself by an unusual irritation, and is resisted by all the normal tendencies; and that the influence, whatever it is, which governs the normal growth, may have a certain limited power of recovering the organism from its abnormal condition, by withholding its impulse from certain parts. But even if we suppose this to be the case, we must suppose a certain struggle for existence, in which one of the divisions of the vertebral column is crushed out of being altogether, while as regards the limbs, the advantage remains with the two which have most room to expand.

It may be further pointed out that the occasional more or less fission of the blastema normally destined for one embryo shows the existence of a capability of fission which must be present in every instance, although only in some instances making itself manifest; and each of the masses into which one embryonic mass is capable of dividing must, as it inherits every property, inherit this latent capability also, and so on indefinitely. That this is the case appears to be indicated by the figure given by Ahlfeld* of the tricephalus which was born in Italy, in 1831. For in that drawing a second abcranial fission has taken place in one of the parts into which a first fission has previously divided the cephalic end of the embryo. Also in the remarkable case figured by Ahlfeld † from Fleischmann, there is a parasitic sacral tumour which exhibits, in addition to a left arm and leg, and a finger adherent separately to the right of the tumour, a foot with nine toes evidently not to be accounted for by multiplication of the toes of one foot, but obviously the termination of a composite limb. So that, in this instance,

* Op. cit., Plate XIX.

† Op. cit., Plate VI., fig. 9.

there have entered into the parasite elements of five limbs. The conclusion apparently justified is a very remarkable one, viz., that *every vertebrate animal has at an early period of its existence a latent capability of splitting up indefinitely.*

If comparison be made of the fissiparous division which takes place in double monstrosity with that which occurs in the nucleated corpuscle, other differences will be found besides the circumstance that in the latter case it is one corpuscle which divides, while in the former it is a mass of corpuscles which does so. Attention has now been drawn for a good many years to the complex changes which occur in nuclei before they divide, and those who cherish the chimerical hope that the phenomena of life will one day be reduced to an evolution founded wholly on the laws of inorganic matter, have not been slow to see in those changes evidence of a total rearrangement of molecules, whereby every minute portion of the nucleus, as it was before the changes set in, is distributed equally to each of the two halves into which the whole divides, so as to secure hereditary transmission of similar properties. It is noteworthy that in the fission which results in twins or double monstrosity, nothing analogous can take place. In this case it is a numerous host of corpuscles which divides, and it is quite impossible to imagine that the members of that host shift their places from one part of the mass to another. It follows that individual corpuscles or groups of corpuscles become, after fission of the mass, ancestors of the textural elements of totally different parts of the body from those which they would have had to do with had the stimulus to fission not been given. It clearly follows that the power by which the different parts and organs of the organism are determined is not resident in the individual corpuscles. For, in that case, the corpuscles destined to give rise normally to mesial structures could not, by any stimulus, become the originators of lateral organs, nor could the laterally situated corpuscles, whose normal destination was to form the groundwork of lateral parts, leave that office and become the sources of crania, vertebral columns, and cerebro-spinal axes. But this is exactly what does take place, when fission of the embryonic shield occurs. Therefore *the factor which models one part into a vertebra, another into a rib, and another into a portion of the sternum is not locked up in the physical properties of the molecules of the separate corpuscles, and there is in an organism, a moulding power additional to the physical properties of the molecules.*

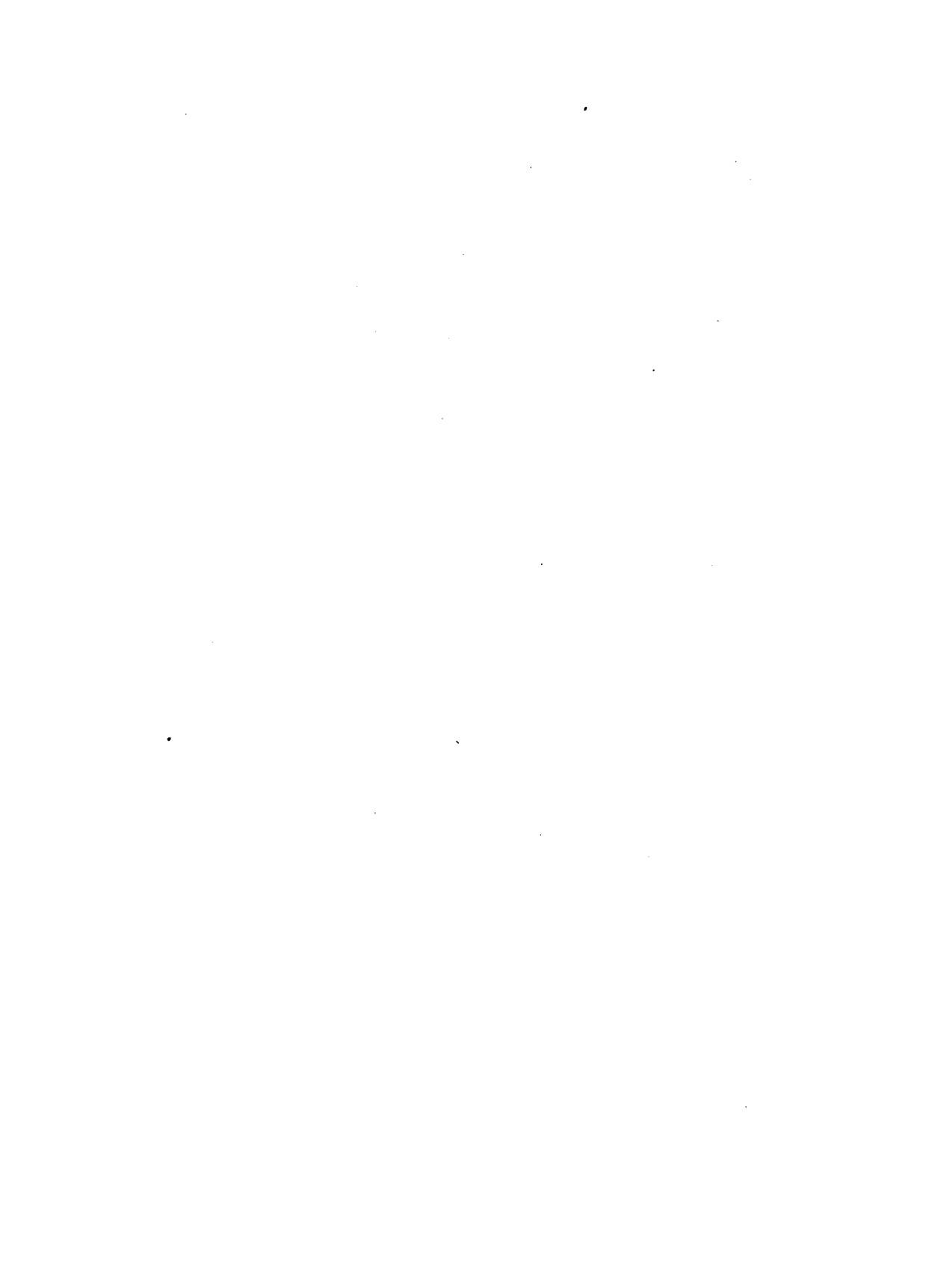


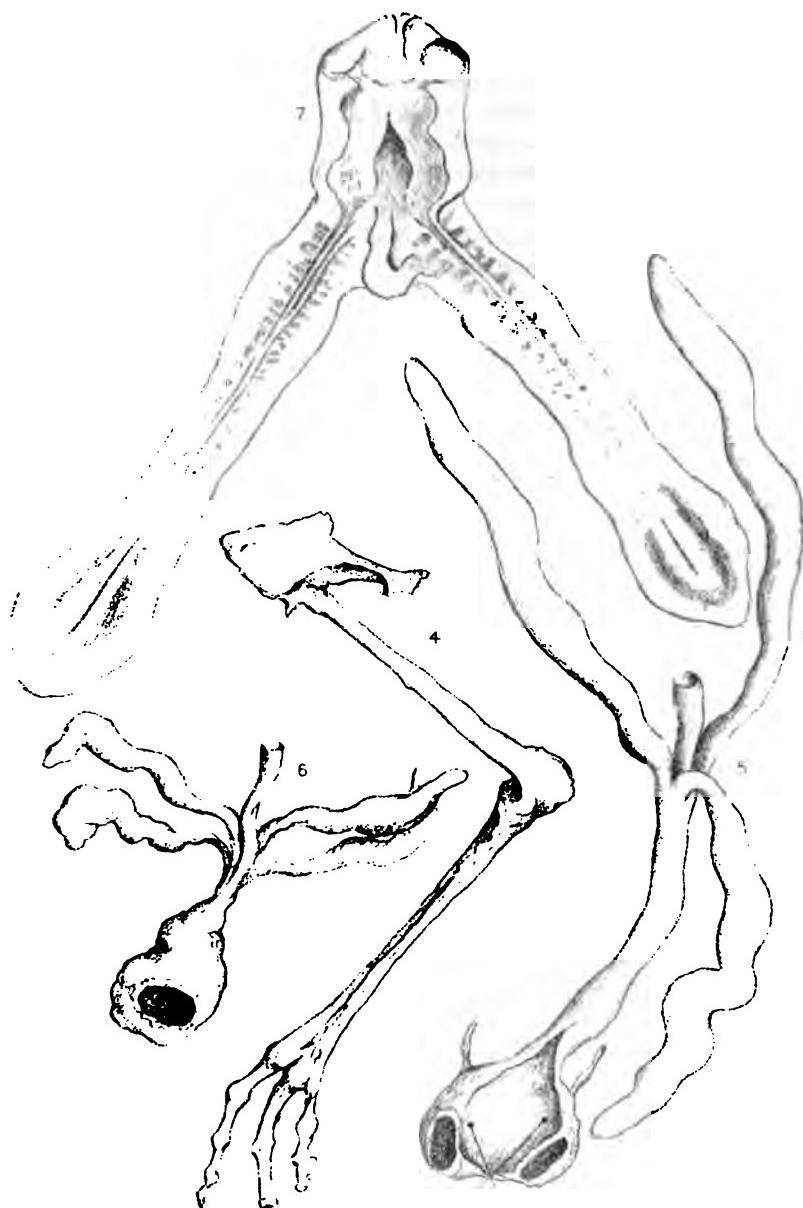
Fig. 7.



Fig.

Fig.





There is abundant other evidence of this, not so satisfactory perhaps to the mere experimentalist as I trust this argument will be, but I shall only refer to one which is specially pertinent to the subject of this paper. Two of the birds described illustrate the law that in fission the alimentary canal is slower to divide than the parts belonging to the somatopleure. But we have in one case a single intestine giving off two pairs of cæca and in another case giving off three cæca. In both cases the intestine is part-property of each of the original divisions of the vertebral column; and in the second case one of the cæca is in the same position. This illustrates that processes coming off from the digestive tube may be multiplied when the tube itself remains single. Still it might be maintained that one half of the digestive tube belonged to each division of the embryo. Such an explanation, however, entirely fails in applicability to double-bodied monsters with one pharynx, two tracheæ, and two pairs of lungs; for as I have elsewhere pointed out,* each trachea in those cases belongs to the vertebral column at the opposite side of the pharynx: therefore the moulding powers of two individualities are at work in areas overlapping one another.

EXPLANATION OF PLATES.

Fig. 1.—Skeleton of goose with supernumerary composite limb attached to supernumerary pelvic elements on the right of the spinal column. Specimen 2nd.

Fig. 2.—Pelvis of pheasant with supernumerary limb attached to pelvic elements on the left of the spinal column; ventral view. Specimen 1st.

Fig. 3.—Chick with two supernumerary limbs. Specimen 3rd.

Fig. 4.—Supernumerary limb from a pheasant. This limb was unconnected with the rest of the skeleton, and belonged to specimen 4th.

Fig. 5.—Hind part of intestine from specimen 4th, with three cæca and two cloacal openings. Bristles are represented in the orifices of the two ureters.

Fig. 6.—Hinder part of intestine of specimen 3rd, with four cæca.

Fig. 7.—Abcaudal fission in a chick of about thirty-six hours' hatching. The fission extends forwards to the back of the first cerebral vesicle. The heart is single.

* *Jour. Anat. and Phys.*, May, 1874, p. 257.

XVI.—*On a New Form of Galvanometer.* By Professor
JAMES BLYTH, M.A., F.R.S.E.

[Read before the Society, 17th February, 1886.]

THE object of this short communication is to describe a method of measuring electric currents by means of an instrument whose scale is graduated to equal divisions, and whose deflections are, from the intrinsic nature of the instrument, proportional to the current strength through all ranges.

In principle the instrument depends upon the mechanical action exerted by a magnetic field upon a movable conductor carrying a current. In construction it is essentially similar to the well-known apparatus, due to Faraday, for showing the continuous rotation across the lines of magnetic force of a horizontal radial conductor carrying a current and having slipping contacts at its centre and circumference. The construction will be understood from the following description.

Two bundles of permanently magnetised steel wires are made up in the form of cylinders having narrow axial holes. These are fixed with their axes in the same vertical line, separated by a narrow gap, and so that the north poles of the one set of magnets face the south poles of the other. In this gap the magnetic field is sensibly uniform and the lines of force vertical. Inserted in the gap is a thin circular disc of wood or vulcanite, having a central mercury cup and a concentric circular mercury trough at a short distance from it. A stout brass rod is provided, having a short thick copper wire rigidly attached at right angles to its lower end. Its upper end passes freely through the axial hole in the upper magnet, and is rigidly attached to the lower end of a long fine torsion wire of steel or silver, whose upper end is fixed to a suitable support. The lower end of the brass rod dips into the central mercury cup, and the outer end of the copper wire (bent down a little at right angles) dips into the concentric canal of mercury. Stout copper wires are led from the central cup and canal to binding-screws suitably placed so as to form the terminals of the instrument. The upper end of the brass rod, which projects a little above the upper magnet, carries a long pointer, which moves over a horizontal circular disc, graduated either to degrees or to show amperes directly. This disc is fixed with the torsion

wire passing freely through its centre. The whole is so enclosed as to be free from air current.

The action of the instrument will be easily understood. Suppose a current sent through it. As is well known, the electro-magnetic force acting on the radial current will tend to make it rotate in a horizontal plane with a uniform force. This rotation will go on till a certain angle is reached, when the moment due to the electro-magnetic force is balanced by the moment due to the torsion of the wire.

Let

i = the current strength,
 a = the length of the radial wire,
 N = the magnetic induction,
 A = the torsion constant,
 θ = the angle of equilibrium,

we have

$$\frac{1}{2}ia^2N = A\theta; \text{ or } i = \frac{2A}{a^2N}\theta,$$

showing that the current strength is proportional to the angle of deflection.

The instrument admits of several modifications. I have constructed two in addition to the above. In the one the permanent magnets are replaced by similarly placed electro-magnetic coils, through which the current to be measured passes. In this case the square of the current strength is proportional to the angle of deflection. In the other the fixed magnets are dispensed with, and, instead, a cylindrical bundle of magnets is fixed coaxially to the brass rod, but insulated from it, so that it rotates along with the rod and radial wire. In this case the radial wire projects from the middle of the length of the magnet bundle, while the lower end of the brass rod is prolonged so as to dip into a mercury cup at a considerable distance below the lower end of the bundle. Owing to the influence of the exterior part of the circuit leading from the mercury canal to the cup, the equation for this case is a little more complicated. With proper arrangements, however, the deflection can be shown to be proportional to the current strength.

In the instruments constructed for practical use the mercury cup and canal are so made, on the unspillable ink-bottle principle, as to preserve the mercury in case of being knocked over or even inverted.

XVII.—*The first History of Chemistry.* By JOHN FERGUSON,
M.A., Professor of Chemistry in the University of Glasgow.

[Read before the Society, 6th January, 1886.]

§ 1.—Next to the interest of tracing the growth of the science of chemistry by its history, is that of observing how this history was regarded at particular epochs; that is, of observing how the development of historical views kept pace with that of the science itself. The history of any period in chemistry must always be coloured more or less by the ideas current at the time of its writing; it must be tacitly or professedly a consideration and narrative, if not a criticism, of past events from the standpoint of a later time, while necessarily limited by that time. The historian, indeed, can hardly be in line with, much less venture to transcend, the most novel discoveries and hypotheses of his contemporaries, he must take up his position on what seem to be the best established doctrines of his time. Thus, for example, while it was quite impossible that Bergman could have written a history of the events connected with oxygen—because for him they either had not come into existence at all, or else were just shaping themselves—it was equally impossible for him to have judged the alchemical period in the same way as was done by Olaus Borrichius, a century earlier. For, during that century, discovery and theory and knowledge had greatly advanced, the period during which Bergman lived was no longer one in which a belief in the reality, or even possibility, of transmutation prevailed, but was that of the much more comprehensive hypothesis of phlogiston, and he of necessity judged the past through the medium of that hypothesis. Or, to select a still more striking case, which the author about to be spoken of affords. If we compare the view of the Greek alchemical manuscripts taken three hundred years ago by the French chemist, Vallensis, with that in the work published this last year on the same subject by one of the leading French chemists of the present time, M. Berthelot, we shall see in how entirely different a manner the same topic is treated. It is not merely that Vallensis had not and could not have had the same knowledge, but

the questions to be answered by an examination of the manuscripts, the way of looking at the questions, the manner of answering them—everything is different. The manuscripts are examined and interpreted at the present time, not for the sake of either defending or attacking the truth of alchemy, but for ascertaining, critically and dispassionately, when this first chemical idea—the idea of transmutation—originated, and what light the manuscripts throw upon its history; and their meaning is illustrated not by comparison with the results of modern chemistry alone, but also from the researches that have been carried on so long into the history and learning of the ancient world—themes undreamt of in the middle of the sixteenth century. It would have been as impossible for Berthelot to have gone back to the standpoint of Vallensis, as it was certainly impossible for Vallensis to have had any foreknowledge of the aids now at the disposal of the chemical archaeologist and historian. In fact, the archaeology of chemistry, if it has not been actually called into existence, has been stimulated at least, by the progress of archaeology in general. But for the interpretation of the languages of the Egyptians and other ancient peoples, the discovery and editing of papyri, the examination of the multitudinous objects of religion, of art and of everyday life, which have been preserved to us from long bygone times, and the possibility of solving other problems by the help which all these have put within our reach, the early history of chemistry could have advanced very little. Even the disposition of mind to take up so apparently fruitless a topic as the origin of the notion of transmutation was wanting but a little while ago, when foregone conclusions against any subject were quite enough to prevent investigation of it. The comparison of histories of the same subject written at different times, in very different surroundings, by men holding opinions at very different stages of development, thus becomes valuable, not merely for the record of events which they each contain, but also because they illustrate the growth of knowledge of the topics treated of, as well as of the manner in which they are treated. Successive histories form an all-important possession for the elucidation of the rate of progress, and for the consideration of the principles which such a subject as chemistry follows in its growth, and of the conditions under which it moves forward. Before the student of the histories and history of his science are passed in steady review the relations it bears to other sciences; the mode in which its theories

originate, attain their maximum influence and disappear, absorbed in others more comprehensive; the attitude which the advocates of newer views assume towards those persuaded of the truth of older; lastly, what of scientific law each successive historian has been able to evolve from the multitudinous details of his narrative, and the success which has attended his efforts to present it to his contemporaries and preserve it for his successors.

§ 2.—The attempt to elaborate a philosophy of science—chemistry included—on a historical basis, was made many years ago by Dr. Whewell; but no one has tried to give a critical examination of the histories of chemistry in order of time, that is to write a chronicle of chemical histories, for the purpose of showing how the science developed, how at successive times it was thought this development should be described, and how it actually was described. It is not my intention even to start such an investigation on the present occasion, but merely to give a notice of a little work which may be regarded as containing one of the first attempts, if not absolutely the first, to collect materials for the avowed purpose of proving the antiquity of the science. The work itself is uncommon; what little is known about the author is imperfectly given; his name just appears in the histories of chemistry, and is not to be found at all in English books of reference, so that some notice of him may not be superfluous seeing that his book would certainly be one of the first in a survey of chemical histories such as that indicated above.

The subject falls into three parts: I. the author's life; II. the book on the truth and antiquity of chemistry; and III. the author's treatment of the subject.

I.—THE AUTHOR'S LIFE.

§ 3.—The author was a Frenchman, whose name was ROBERT DUVAL, or in its Latinized form, ROBERTUS DE VALLE, or ROBERTUS VALLENSIS.* He was born in the latter part of the fifteenth

* He is called *Robertus de Valle* in the title of his abridgement of Pliny, as quoted by Harduinus (*Plinii . . . Naturalis Historia Libri XXXVII.* Paris, 1685, vol. I. Preface to the Reader). Elsewhere it is *Robertus Vallensis*. On the title-page of Hutton's *Ars versificatoria*, Paris, 1559, the name is curiously misprinted *Robertus Valdensis*. Watt (*Bibl. Brit.* 1824, II. 809 e), enters him erroneously as *Robertus Tallensis*, and J. F. John (*Handwörterbuch der . . . Chemie*, Leipzig, 1817, I. p. 161) styles him *Robertus Vallesis*.

century, some authorities say at Rugles, others at Rouen.* In his first book he is styled *Rothomagensis*, i.e., of Rouen, but, so far as I know, it is only in this book that this designation appears. Everywhere else his name is followed by the epithet: *Rugl.*, which is a contraction for *Rugensis*. He was a canon of Chartres, who, judging by his writings, was interested in natural history, and who was led away, like many of his contemporaries, by the fascinations of alchemy.

§ 4.—Of his life apart from his writings there is no record. His first book was an abridgement of Pliny's Natural History which he dedicated to René, bishop of Chartres, and of which the first edition was printed in 1500. Along with it Vallensis published an *Explanatio Locorum Plinii difficiliorum ordine alphabetico*, Paris, by Durand Gerlier, 1500, in 4to.† Another edition appeared in 1505. The title is as follows: "Roberti de Valle Rothomagensis compendium memorandorum vires naturales et commoda cōprehendens à Plinio data; valens nedium ad secreta nature noscenda; sed ad vsus quoqz necessarios; corporisqz et ingenii cōseruationē; Impressum Parisii (sic) per Felicem Baligault impensa magistri Durandi Gerlier, anno 1505," in small 4to.‡ It was reprinted in 1520 in 4to, and this edition was also published by Durand Gerlier.§ There was another in 1600 in 4to, but I have seen no detailed notice of it.|| All the editions seem to be of great rarity. There is one of the 1505 edition

* The *Biographie Universelle* says at Rugles, Lebreton (*Biographie Normande*, Rouen, 1857, I. p. 529) says he was born at Rouen or at Rugles, but Frère (*Manuel du Bibliographe Normand*, Rouen, 1858, I. p. 415) says definitely that he was born at Rouen and that the *Biographie Universelle* is in error. I am quite unable to decide who is right. Schmieder (*Geschichte der Alchemie*, Halle, 1832, p. 278) hazards the guess that he was a German, that his name was Robert Thaler and that he was a native of Ruhland, in Oberlausitz! Kopp (*Beiträge*, Braunschweig, 1869, p. 322) say he knows nothing about him, which is strange, considering that there is an article on him in the *Biographie Universelle* and that Poggendorff (*Biographisch-literarisches Handwörterbuch*, 1863, I. col. 635,) also mentions him.

† Graesse, *Trésor de Livres Rares*, Dresden, 1867, T. VI. ii. p. 251. Graesse does not seem to have known that *Robertus de Valle* was the same person as *Robertus Vallensis*.

‡ Ed. Frère, *Manuel du Bibliographe Normand*, I. p. 415.

§ *Biographie Universelle. Nouvelle Biographie Générale.* Lebreton *Biographie Normande*, I. p. 529.

|| Lebreton, *Ibid.*

in the library at Rouen,* but of the others I know of no copies; there is none of them in the British Museum. It must have been a work of the author's youth, perhaps a sort of school abridgement, as it purports to have been written *ad corrupti sermonis latini emendationem*. The youth of its author also may have prevented it being of any value as a contribution to Plinian literature, and this may form a slight defence against the crushing verdict passed on it by Harduin, when he † describes it as: *opus nullius eruditio[n]is, nulliusque fructus, aut pretii.*‡

§ 5.—A considerable number of years later appeared what probably was his second work—*Commentarius in artem versificatoriam Hulderici Hutteni*. It appeared, according to Graesse: § *C. comment. Roberti Vallensis Raglensis* (sic) *Paris. ap. Joa. Yuernel. 1530. pet. in-8°. (40 ff.)*; and again: (*av. ce comm.*) *Paris. ap. Prigentium Caluarin in clauso Brunelli ad insigne Geminarū Cypparū. 1537. in-8°. (40 pp. ch.)*. There was also an edition, Paris, 1535, in 8vo.|| I have not seen any of these. The copies of the work which I have seen are in the British Museum, and are dated respectively 1551 and 1559. As this commentary of Vallensis is quite unknown to every one who has written a notice of him, it may not be out of place to quote the titles of the two editions:—

1551.—*Commentarius In Artes | Versificatoriam Hvilde- | rici Huteni,*
cùm perbreui accessione primarum & | mediarum syllabarum, atque
specierum carminis, à | Roberto Vallensi Ruglensi editus: ac denuo ab
eodem | auctus & recognitus.

Præterea adiectum est ad finem compendium | de Accentibus &
periodis, siue clausularum | punctis.

*Lvtetiae, | Ex typographia Matthæi Dauidis, via | amygdalina, ad
Veritatis insigne. | 1551. |*

It is a small 4to, and contains pp. 55.

* Frère, *Manuel du Bibliographe Normand*, I. p. 415.

† Harduin, *Plinii . . . Naturalis Historiae Libri XXXVII.* Paris, 1685, vol. I. Preface to the Reader.

‡ In 1587 there was printed at London in small 4to, a black letter tract—*The Secrets and wonders of the worlde . . . Abstracted out of that excellent naturall Historiographer Plinie.* Is this a translation of Vallensis' Compendium, or has it anything to do with it? For a short notice of it see Part IV. of my *Bibliographical Notes on Histories of Inventions and Books of Secrets*, communicated to the *Archæological Society of Glasgow*, in January, 1885.

§ Graesse, *Trésor de Livres Rares*, Dresden, 1862, T. III. p. 397.

|| Panzer, *Annales Typographici*, Norimb. 1800, VIII. p. 192, No. 2518.

The other copy has a different title-page :—

1559.—Commentariis | In Artem Versificato- | riam Hulderici Hutteni,
cum perbreui accessione | primarum & mediарum syllabarum, atque
| specierum carminis, à Roberto Valdensi (*sic*) | Ruglensi editus : ac
denuò ab | eodem auctus & re- | cognitus. | Præterea adiectum est ad
finem, Compendium de Accentibus, | & Periodis, siue clausularum
punctis. | Parisiis, | Apud Gabrielem Buon, in Clauso Brunello, | ad
D. Claudij insigne. | 1559. |

It is a small 4to, and contains ff. 28.

This too may have been a sort of school book written to promote scholarship and the appreciation of the technicalities of Latin verse.

§ 6.—The same year, 1559, he is said * to have edited the first edition of the chemical treatise ascribed to Morienus, *De Transfiguratione Metallorum*; two years later, in 1561, he brought out the little work on the Verity and Antiquity of Chemistry, which is specially the theme of the present notes, and to which fuller reference will be made presently, and in 1564 he certainly edited the second edition of Morienus.

§ 7.—With regard to the 1559 edition of Morienus, I am not prepared to say that Vallensis was not the editor. There is no direct proof, however, that he was; for the introductory address to the reader, which informs him that two Latin versions were employed, the best, by Castrensis, having been used to form the basis of the text, and the various readings of the other anonymous version being added on the margin, gives no indication as to who saw the book through the press, whether it was the printer, Guillard, himself, or some one else. On the other hand, however, the very last page contains two Latin couplets by Vallensis, so that it is quite possible that he had something to do with it.

The title is as follows :—

Moriēni | Romani, Qvondam | Eremitae Hierosolymitani, | de trans-
figuratione metallorum, & oc- | culta, summaq[ue] antiquorum Phi- |
losophorum medicina, Li- | bellus, nusquam hacte- | nus in lucem |
editus. | Cvm Privilegio. | Parisiis, | Apud Gulielmum Guillard, in
via Iaco- | bæa, sub diuæ Barbaræ signo. | 1559. |

It is a small 4to, ff. [2] 34.

Both the first and second editions of Morienus are to be put certainly among the rarities of alchemical literature. The second edition is perhaps the rarer of the two.

* *Biographie Universelle. Nouvelle Biographie Générale.* Neither of the editions of Morienus is quoted by Lebreton and Frère.

§ 8.—As to Vallensis' revision of the second edition there is no doubt, for the title gives full details. It is as follows:—

Moriensi | Romani, Qvondam | Eremitae Hierosolymitani, De | re Metallica,
 Metallorum transmutatione, | & occulta summaq; antiquorum medicina
 | Libellus, præter priorē editionem accuratè | recognitus. | Item, Nunc
 primum in Lucem prodit | Bernardi Treuirensis Responsio ad Thomā |
 de Bononia Caroli Regis octauī medicum | de Mineralibus, & Elixiris
 sen pulueris phi | losophici compositione, quæ pars est secre | tioris
 phisicæ, scholiis aliquot per Robertū | Vallensem Rugl. Illustrata. |
 Ad calcem adduntur | Tabulæ breues ab eodem R. Vallensi conscriptæ
 quæ antiquorū | intentionem de pulueris philosophici compositione,
 abstrusia eorum | scriptis & ænigmatibus inuolutam, declarant | Cum
 Indice copiosissimo. | Parisiis, | Apud Gulielmum Guillard, via Iacobæ
 sub | D. Barbaræ signo. | M.D.LXIIII |

It is a small 4to, ff. [2] 66 [4].

In the prefatory note of Vallensis to this edition, he states that Guillard, the printer, being desirous of bringing out a few tracts περὶ χημείας, about chemistry, and especially that of Morienus, "which had been already once printed by him," asked Vallensis if he could contribute anything from his collection that would throw light upon the puzzling passages in Morienus; whereupon he selected the Epistle of Bernard of Trevisan to Thomas of Bononia, edited it very carefully from a number of copies (presumably in manuscript), added a marginal commentary, and had it printed for the first time. From the way he speaks one would infer that Vallensis had supervised this second edition only, and not the first, but there is nothing sufficiently explicit to enable the question to be decided with certainty. His aim in taking this trouble was the good of those who wished to have trustworthy instruction in the art, and to escape from the wiles of sophists and impostors. For he does not doubt that in consequence of the frauds practised by self-styled chemists many considered the art altogether delusive or extremely difficult, and in its results most uncertain; whereas he says that in his little book, previously published, *De veritate et antiquitate artis chemicæ*, he had collected the testimonies to its truth from the writings of distinguished theologians, jurists, physicians, and philosophers, and so he commends his labours to the true students of chemistry, with the hope that they will not fail to attain it, so profitable as it is to humanity, both for the making of gold and silver, and for preserving the body in health and warding off from it disease. Vallensis was undoubtedly a believer in the existence and virtues of the philosophical elixir, after which so many men ran for centuries.

§ 9.—The two tables which, as stated in the title, are affixed to the second edition, were intended by Vallensis still further to simplify the subject. The first is dedicated to Petrus Drouet,* and is intended to show that native minerals are composed of mercury and sulphur, and that mercury is of two kinds, common and philosophic; and secondly, that the philosophic powder is similarly composed of mercury and sulphur, and he gives a long list of synonyms of these two elements which correspond, each for each.

It is an early and very rudimentary attempt to give an elementary analysis of certain natural substances, and to state the results in a tabular form. This table is followed by a collection of fifty-one brief sentences, aphorisms and dark sayings on the same recondite theme, extracted from a number of authors. So far as I have observed, the second table is to be found only in this edition of Morienus, but the first table was reprinted several times.†

§ 10.—To Vallensis also is ascribed the authorship of an alchemical work entitled, *Gloria Mundi, alias Paradysi Tabula.*‡ What may have given rise to this is the fact that at the end of the introduction his name appears, and along with it another version of the Latin couplets contained in the editions of Morienus, with this difference that the two couplets have been expanded to

* Petrus Drouet was a physician at Paris, and wrote a tract, *Consilium novum de pestilentia*, Paris, 1573. His name is misspelt *Douet* in the reprint of Vallensis' table in the *Ars Aurifera*, 1593 and 1610; and in the 1613 German translation this is further metamorphosed into Peter *Soret* (!), which is repeated by Fictuld (*Probier-Stein*, Frankfurt, 1753, part I. p. 135).

† The reprints are to be found in the different editions of the collection of alchemical writings entitled *Ars Aurifera*; Basileæ, 1572, II. pp. 112-114; Basileæ, 1593, II. pp. 104-106; Basileæ, 1610, II. pp. 69-70; and in the German translation, *Turba Philosophorum*, Basel, 1613, II. pp. 91-93.

‡ Mercklin (*Lindenius Renovatus*, Norimb. 1686, p. 945, copied by Fuchs, *Repertorium*, 1806, I. i. p. 95), is the only person who makes this statement. Roth-Scholtz (*Deutsches Theatrum Chemicum*, Nürnb. 1732, III. p. 358) says it is by an unknown writer, and Fictuld (*Probier-Stein*, 1753, part I. p. 83)—if that be really his name—says it is either by a certain Barcius or by Johaun von Sternberg. To Fictuld's statements, however, no value can be attached. The earliest recorded edition of the *Gloria Mundi* is of date 1620, but I have not seen it. The others (of which I have seen those with the asterisk) are *Museum Hermeticum*, *1625, *1678, and *1749; Roth-Scholtz's *Deutsches Theatrum Chemicum*, Nürnb., *1732, vol. III. pp. 357-536; separate editions, Frankfurt, 1648; Hamburg, 1692; and a German translation, Hof, *1774.

six. There can be little doubt that Vallensis is not the author of this work, and it is safe to say that the editorship of the *Rosarium*, another alchemical compilation, is also erroneously assigned to him.*

§ 11. Besides the works just mentioned, he is said to have composed some of an ascetic character, of one of which the title is given : † *Traité des dispositions nécessaires pour mourir saintement*, 1567. It seems to have been prophetic, for this same year he died at Rugles.

II.—THE HISTORY OF CHEMISTRY.

§ 12.—I come now to the second head of the subject—the little work already quoted—which was an attempt to vindicate the importance and truth of the art of transmutation by an appeal to its antiquity, and to the continuous succession of allusions to it by writers of all ages, and on very different topics. It is said that it was a book in great request among the devotees of the art, but it seems to me that it was not really so, for only a very few editions of it appeared.‡ The *Biographie Universelle* says, very sapiently, that the statements of Vallensis will not be accepted without examination, meaning, of course, that what may have appeared true and irrefragable to Vallensis was not really so to the savant of 1814, when the *Biographie Universelle* article was written. To be sure—nor would one take the statements even of the *Biographie Universelle* itself without a considerable amount of caution, for mistakes occur even in it. But I suppose one may consider the opinions of Vallensis as those that he believed to be true at all events. Before passing them in review, however, a list of the different editions of the work may first be given.

§ 13.—

1.—1561. De Veritate Et Antiquitate Artis Chymicæ, & Pulueris, siue Medicinæ philosophorū, siuo Auri potabilis materia & compositione, illiusque mira vi in tria rerū genera Animale, Vegetale, & Minerale, Testimonia & Theorematæ : Ex uariis authoribus sacris, Theologis, Iurisperitis, Medicis, Philosophis, & Poetis, per Robertum Vallensem selecta.

Parisiis, Apud Federicum Morellum, in vico Bellouaco, ad vrbanam Morum. M.D.LXI.

* Fictuld, *Probier-Stein*, I. p. 135.

† In the *Biographie Universelle*, and by Lebreton and Frère. There is no copy of this work in the British Museum

‡ Nor was it much quoted. Penotus (*The Alchymists Enchiridion*, London, 1692) refers to it, however, and borrows several extracts from it.

16mo, no pagination, signatures A—F in eights, or 48 leaves in all.
Printed in italics throughout.

This edition is quoted in the *Biographie Universelle* and the *Nouvelle Biographie Générale*, by Lebreton and Frère, by Watt (*Bibl. Brit.*, II. 809e), and by Kopp (*Beiträge* 1867, p. 322). There is a copy in the British Museum, but it is a book of the greatest rarity, as it has possibly been easily destroyed in consequence of its tiny dimensions.

2.—1591. According to Ladrague (*Bibliothèque Ouvaroff, Sciences Secrètes*, Moscow, 1870, p. 56, No. 546), the first edition appeared, "Lugduni, 1591." This is an obvious mistake. Evidently there is no copy of a 1591 edition in the Ouvaroff collection, for Ladrague's statement is appended as a note to the reprint contained in the *Theatrum Chemicum of 1613*. Ladrague may have made some confusion, for he is not always correct about the dates of first editions; but it is possible that there was an issue two years earlier of the book which is next on the list. Anyhow, I have seen no copy, and no other mention of a 1591 edition except the present.

3.—1593. De Veritate Et Antiquitate Artis Chemicæ Et Pylveris Sive Medicinæ Philosophorum Vel Avri Potabilis, Déque illius materiâ & compositione, eiisque mirâ vi in tria rerum genera Animale, Vegetale & Minerale, Testimonia Et Theorematum, ex variis auctoribus sacris, Theologis, Iurisperitis, Medicis, Philosophis, & Poëtis, per Robertvm Vallensem selecta.

Lvgdvni Batavorvm, Ex Officina Plantiniana, Apud Franciscum Raphelengium. cIo. Io. xciii.

Small 8vo, pp. 46, and 2 blank.

This edition is well known. It is referred to by Draudius (*Bibliotheca Classica*, Francofurti, 1625, p. 899); by Zedler (*Universal-Lexicon*, Leipzig, 1745, Bd. 46, col. 380); by Gmelin (*Geschichte der Chemie*, Göttingen, 1797, I. p. 297); by Watt (*Bibl. Brit.*, II. 809e). It is in the British Museum.

4.—1600. According to Draudius (*Bibliotheca Classica*, Francofurti, 1625, p. 899) the tract was reprinted "Basilee apud Ludou. Koenig, 8. 1600." Lenglet Dufresnoy (*Histoire de la Philosophie Hermétique*, Paris, 1742, T. III. p. 319) has repeated this statement omitting the place, and Schmieder simply gives the date, without either place or printer's name. I have not seen a copy of this edition.

5.—1601. De Arte Chemicâ Libri Dvo, Quibus omnia, quæ ad lapidis siue pulueris philosophici compositionem vsumque spectant, breuiter & aperte traduntur. Qvorvm Prior De veritate & antiquitate artis Chemicæ & pulueris siue medicinæ Philosophorum vel auri potabilis Testimonia & Theorematum ex varijs auctoribus per Robertvm Vallensem selecta. Posterior. Ioan. Chrysippi Faniani de arte metallicæ metamorphoseos liber singularis. Item de Iure Artis Alchemicæ veterum auctorum & præsertim Iurisconsultorum Iudicia & responsa

ad quæstionem An Alchemia sit ars legitima. Ob argumenti, tractationis methodiq; similitudinem coniunctim in gratiam Philochemistarum editi. Montisbeligardi, Apud Iacobvm Foillet, M. DC. I. Small 8vo, pp. 51; [6] 67.

- 6.—1602. There is another Montbeliard edition of this year. The title-page and the book throughout are identical with that published by Jacques Foillet in 1601, except that the date is M.DC.II. I suppose that in the remaining copies another I was inserted after the C. It contains pp. 51; [6] 67.

No notice either of this or of the preceding edition is taken by any writer whatever. There is a copy of this edition in the British Museum, but none of the year earlier.

- 7.—1602. According to Mercklin (*Lindenius Renovatus*, Norimb. 1686, p. 945), it was reprinted "Basileæ, ap. Ludovicum König, 1602, in 8." This, therefore, would be a reissue of the 1600 edition. I have not seen a copy.
- 8.—1602. The tract is contained in the *Theatrum Chemicum*, Ursellis, M.DCII. Vol. I. pp. 1-27.
- 9.—1602. There is an edition said to have been printed at Upsala in this year: *Rob. Vallensis (sic) de veritate et antiquitate artis chemia*, etc. Upsal, 1602. (See J. F. John's *Handwörterbuch der allgemeinen chemie*, Leipzig, 1817, 8vo, Bd. I. p. 161. Note.) A statement to the same effect had been made by Fuchs in 1806 (*Repertorium*, I. i. p. 99): *Rob. Vallensis De Veritate et antiquitate chemie et auro potabili Vps. 8.* It seems to me that this is a misprint for *Vrs.*, that is *Ursellis*, and that John has not observed it, but has aggravated it by writing the word at greater length. I know of no copy, and have seen no other mention of the book than the above.
- 10.—1613. The tract was again reprinted in the *Theatrum Chemicum*, Argentorati, 1613, Vol. I. pp. 1-24.
- 11.—1659. The last reprint that I know of was in the *Theatrum Chemicum*, Argentorati, 1659, Vol. I. p. 7-29. These reprints are not commonly referred to by those who have written about Vallensis.
- 12.—In the British Museum (Sloane MSS. 1806. Sæc. XVII. 12mo. ff. 1-50), there is a translation into English of the "*De veritate et antiquitate artis chemice.*" It follows the original closely, but some passages have been curtailed. So far as I know it was never printed. I am not aware of a translation of the treatise in any other modern language.

III.—THE SUBJECT.

§ 14.—When we turn to the work itself and ask what was its author's intention, and why it was thought of importance to discuss the question of the antiquity of the art at all, and how its truth and antiquity were proved, we find, it must be admitted,

a rather feeble essay, though sufficiently curious and interesting as a first attempt.

The reason for writing it was that, owing to the pretensions of many self-styled adepts, and of frauds perpetrated by them, most reasonable people disbelieved in the whole affair, and would have nothing to say even to those who, by chemistry, were able to produce some genuine and useful results, and Vallensis wanted to counteract this prejudice and vindicate the value of chemistry if he could.

§ 15.—In the strict sense of the term it cannot be called a history, for there is no narrative of the progress of the notion of transmutation. It is an attempt to prove the antiquity of the art by a collection of extracts from various writers, sacred and profane, some of which certainly do refer to transmutation, and the composition of the metals, while others are interpreted as referring to it. Interspersed are a few comments by Vallensis, partly explanatory and apologetic, partly historical.

It need hardly be said that it never occurs to Vallensis to criticise the passages he quotes. He accepts them as they stand, as authoritative evidence in favour of transmutation, and he explains them according to the views he held as to the composition of the metals. From what he says both in his Table (§ 9), as well as in his history, Vallensis held the then ordinary hypothesis that the metals are composed of sulphur and mercury, so-called, and that the different metals result from the different degrees of purity of these elemental substances, as well as from the different degrees of digestion or concoction of them with one another. This theory had been enunciated by Geber eight hundred years earlier, and it is probably still older, but, deeming that view to be entirely correct, Vallensis could describe the passage of one metal into another as “easy.” On such a basis, and when the sciences were in an even more imperfect state than chemistry, and the crudest notions were current, it was not difficult to argue in favour of transmutation. One thing, however, he does not do—he records no instance of actual transformation.* That was reserved for the 18th century—a later, more ignorant, superstitious, credulous, and sceptical time—to describe. But one instance, clear, undoubted, and capable of repetition, would have been worth volumes of arguments a thousand times larger than Vallensis’ mite of a book.

* Gmelin implies that he does.

§ 16. He begins by giving in the preface the derivation of the name *Chemistry* or *Chemia*, from the Greek χέω, meaning the art of fusion, the art which investigates the nature of those minerals which melt when heated, and from these teaches the preparation of that powder, or stone, or medicine, which melts like wax in the gentlest fire, and produces the most wonderful effects in the animal, vegetable, and mineral kingdoms. With the Arabic article *al* prefixed, it becomes alchemia or alchymia, but the words denote the same pursuit.

§ 17. He then proceeds to give a few quotations from the sacred writers, in which allusion is made to gold, and to the sun and moon, and to a medicine, and to the purification of silver by the fire, or in an *aludel* or subliming vessel, upon which he has a brief comment. He quotes Geber's account of sublimation, which is straightforward and intelligible, but he assumes it to signify transmutation itself, a meaning which appears forced and quite uncalled for. He takes for granted that these and other references—such, for instance, as the well-known verses by Adam à St. Victor, in which the power of transmutation is ascribed to St. John—are to be interpreted in the alchemical sense, which it is obvious they are not. The Smaragdine Table of Hermes follows, and next from Thomas Aquinas, Duns Scotus, Chrysogonus Polydorus, the lawyers Joannes Andreas and Oldradus, and other writers, are given quotations as to the aim of the art and to its legitimacy. The aim was to produce real gold, not sophisticated gold, and it was argued that there is nothing repugnant in art using natural causes to produce natural and true effects—for instance, to change copper or tin into gold or silver respectively—and if true gold or silver could be produced by art, it was, in the opinion both of the divines and the lawyers, perfectly legitimate to use it in place of the natural metal. The materials to be used were the stone, compounded, it is not said how, from philosophical sulphur and philosophical mercury. The possibility of transmutation was affirmed by these writers partly from the similarity of the metals to each other and partly from apparent transformations in nature, as, for example, the seeming formation of living things from dead matter. That such analogies could pass muster at this stage in the history of science is not surprising, when even yet, in Natural History, the theory of *spontaneous generation* is not without its supporters. The metals, as being ultimately the same in kind, could be more easily changed,

especially when assisted by art. For it was thought that, although it seems to be nature's purpose to attain metallic perfection, yet it takes a long time to do so, and may be altogether prevented unless art step in and remove obstacles; and here Vallensis quotes the beautiful passage from Geber, which is not unworthy of Bacon himself:—" *Similiter et metalla non mutamus, sed natura, cui secundum artificium materiam preparamus: quoniam ipsa per se agit, non nos, nos vero administratores illius sumus.*" From Avicenna, Daustin, and other writers, he quotes parallel passages to the same effect. He then reiterates that the metals are, from their nature, easily transmuted one into the other, and refutes certain theoretical objections to the possibility of a body being changed from the form imposed on it by nature from the beginning.

§ 18.—At this point he requests that they will consider the position they assume, who would subvert Nature itself, and who ignorantly deride chemistry, the finer part of natural philosophy, so necessary to the welfare of mankind, the imitator and rival of its parent, Nature, devoted as it is to the study of the character causes and hidden virtues of all things. And then he quotes Hermes, Suidas, Geber and others who have lauded the art in the most lofty terms; he gives quotations showing the powers of the wonderful stone itself, and its value not only for perfecting the inferior metals and the less noble gems, but for conferring health and curing the sick.

And he expresses the hope that the student may be delivered from the wiles of impostors, who under false names, such as red and white tinctures, augmentations, multiplications, and extracts of gold, knowingly deceive their listeners, promising them many things, even mountains of gold. Whence it happens that the true, noble art of chemistry is treated by most as a mere deception.* From all such cheats who have no claim to be called chemical philosophers at all, the student will hold aloof, and will resign himself to the meditation of the true chemical books and philosophy, not for the sake either of gain or of glory, remembering that success in the art is a divine gift, only bestowed on those who devote themselves to it with a single heart.

Much of this—allowing for the exalted tone of the writer and the mistaken aim of his art—might be impressed with the same

* Similar to this is a portion of the preface to the second edition of Morienus, already quoted (§ 8), which Vallensis wrote three years later.

reason on the modern student of chemistry as on his predecessor three centuries ago. One can only wish that Vallensis had told us in a little more detail what he considered the true chemical books and how they were to be studied. That, however, might have been resented as revealing the secrets to the uninitiated, but doubtless the authors at least from whom he quotes may be reckoned as among those deserving the closest attention.

§ 19.—What may be viewed as the second part of the subject, for there is no distinct arrangement or division, contains extracts from Avicenna, Rhazes, and others, first as to the composition and transmuting power of the elixir or stone, and secondly as to its excellence as a medicine.

After some quotations, not always readily intelligible, from Bernard of Trevisan, Marsilius Ficinus, the pseudo-Aristotle, Geber and Albertus Magnus, he quotes the passage about the branch of gold from the sixth book of the *Aeneid*, and the myth about the golden apples of the Hesperides in their alchemical connection.

§ 20.—Two of the most important quotations, from a historical point of view, which Vallensis makes, succeed. They are taken from Suidas, the first, containing the definition of the art and the story of Diocletian, and the second, Suidas' affirmation that the golden fleece was a parchment book in which the aurific process was described. Vallensis thereupon proceeds to mention the names of some of the authors—Greek, Arabic, Latin—who had written on the subject, and quotes three Greek MSS. preserved in the Royal Library of France, containing writings by Zosimus, Isaac Monachus, and Blemmidas. Among other Greeks whom he enumerates are Democritus, Synesius, Osthanes, Pelagius, Heliodorus, names which have been referred to now more than once in the course of my communications to this Society. These allusions to the Greek MSS., though so brief, are really valuable, for, along with those of Picus Mirandulanus and of Gratarolus, they are among the earliest which are to be met with in modern chemical literature.

§ 21.—Vallensis concludes with a quotation from Picus Mirandulanus to the effect that under the veil of riddles and poetic inventions the ancients were wont to describe the loftiest and divinest truths, and in illustration he quotes a number of these:—Cadmus and the dragon's teeth; Medea and Jason; Saturn; Danaë and the golden shower; Ganymede; Daedalus; and so on, all of which were supposed under various guises to depict the search for

the philosopher's stone, and the transmutation by it of the metals. Even under such forms as the Labyrinth, the Sphinx, the Chimæra, sculptures of animals on temples and palaces, the production of the stone was supposed to be concealed, and as an example of this in modern times Vallensis quotes the figures designed by Nicolas Flamel, which the latter caused to be displayed on the Cemetery of the Innocents at Paris, and which, Vallensis adds, will be understood only of those most learned in the art. It would have been obviously hopeless to bring any criticism to bear on such a system of interpretation as this, or to point out the assumptions which those who welcomed it must have accepted. It marked the progress of that symbolism which at a later period, especially last century, neglected entirely what little experimental basis the art originally possessed, and became a maze in which the would-be expounders fairly lost themselves, and the outcome of which was a multitude of fantastic books that are a discredit to the century which boasted of its illumination. Vallensis concludes that from the evidence he has brought forward the reader will see that chemistry is not a new and uncertain art as the ignorant vulgar of his time imagined.

§ 22.—Certainly without accepting all his quotation in the sense he offers them, we can agree unhesitatingly in his conclusion. But it is hardly worth while discussing the question at all, seeing that far wider research has proved that the chemical art is much older than it has hitherto been the custom to suppose—perhaps even older than Vallensis supposed—and that the origin of the name is surrounded with much obscurity. Some light is beginning to be shed upon these much discussed Greek MSS., and the latest contribution of all is the edition, with a translation, of a Greek alchemical Papyrus, preserved at Leyden, recently published by the venerable custodier of the Museum, Dr. Leemans.*

We may recognise, however, in the imperfect endeavour of Vallensis, the perception of problems to be solved, though he knew neither how to set them nor how to answer them. In fact, the time had not come for making the attempt.

When one remembers the state of opinion in the middle of the sixteenth century, and the questions which agitated the mass of mankind, it is not to be wondered at, that the first history of chemistry should have taken the form of an apology. In the days of Vallensis the chemists or alchemists were looked upon with the

* *Papyri Graeci*, Lugd. Bat., 1885, T. II. p. 199.

strongest suspicion and dislike. It was not believed that they could effect what we know well enough now it was impossible for them to do. But this unbelief, though correct, was based on an ignorance far greater than that of the alchemists, for, whoever at the time had had the same knowledge could not well have avoided the inferences which the alchemists drew. It hindered also the diffusion of the positive knowledge about different substances, which the alchemists certainly accumulated, but to which they appear to have attached value, only in so far as the chemical relationships known advanced them on the way to the realisation of their hopes, and it thus retarded the application of chemistry to the arts to some extent, though not entirely, as my next paper to the Society will show.

Vallensis upheld such chemistry as he knew, for both its scientific and technological value, and tried to demonstrate its fruitfulness in spite of powerful antagonism to it. In these days it will hardly be asserted that the science is without fruit; but some will say that it bears no intellectual fruit comparable with other subjects; and others that the mere study of scientific principles is of very little use indeed for practical applications and for manufactures. Against both views chemistry has still to be on its defence. Its power of combating such objections, however, is very different from what it was three hundred years ago, and is ever becoming greater. Some future historian will doubtless be able to show that, backed as it is by the whole universe of matter, it has overcome all opposition, and that such vindication of its claims—as is still needed—to form part of a liberal, as well as of a professional and technical, education, will seem as antiquated to our successors as to us now appears the laudable effort of Vallensis to prove, as Richard Russell* puts it, that “Chymistry is a true and real art, and (when handled by prudent artists) produceth true and real effects.”

* In his Address to the Reader, prefixed to Geber's *Works*, London, 1678.

NOTE.—To the reprints enumerated in § 9, note †, must be added *Turba Philosophorum*, Vienna, 1750, II. pp. 123-127.

**XVIII.—Enquiry into the effects of Loud Sounds upon the Hearing
of Boilermakers and others who work amid noisy surroundings.**

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[Read before the Society, 3rd March, 1886.]

IT is familiarly known that boilermakers and others who work amid very noisy surroundings are extremely liable to dulness of hearing. In Glasgow we would have little difficulty in finding hundreds whose sense of hearing has thus been irremediably damaged by the noisy character of their work. We have, therefore, in our city ample materials at hand for the investigation of this subject.

In the process of boilermaking, as most of you are aware, four different classes of men are engaged—riveters, caulkers, platers, and “holders-on.” The riveter drives in with a large hammer the red-hot iron rivets for binding the plates together; the caulkers hammers with a chisel the edges of the plates so as to ensure complete tightness; the plater forms the iron plates and arranges them accurately in position; while the “holder-on,” stands inside the boiler holding a large hammer, the head of which he presses against the inner end of a rivet. These are not all equally exposed to loud sounds, and they differ, therefore, in the extent to which their ears are affected. The men who work inside the boiler, such as the “holders-on,” are, of course, exposed to the loudest and most damaging sounds. Their ears are near to the rivet which is being hammered in by the riveter outside. The iron on which they stand is vibrating intensely under the blows of perhaps twenty hammers wielded by twenty powerful men. Confined by the walls of the boiler, the waves of sound are vastly intensified, and strike the tympanum with appalling force, while the vibrations from the iron pass directly through the bodies of the men to the delicate nerve structures in the inner ear. If, in such circumstances, we venture into the interior of a boiler, our first

impulse is to hurry out, or to stop our ears with our fingers. We are conscious not merely of the sound waves, like blows, producing their terrible effects upon our ears, exciting therein sharp, painful, intolerable sensations, but our bodies seem to be enveloped in invisible, yet tangible waves which we actually feel striking against our heads and our hands. When I underwent this experience, I fortunately furnished myself with a couple of India-rubber plugs, and by carefully withdrawing and inserting them in the canals of my ears, I was able at pleasure to admit or shut out the fearful sound. Let no one who values his hearing perform such an experiment without similar precautions. After such an experience one is surprised that the delicate mechanism in the interior of the ears can retain its integrity for a single day under the action of these blows of compressed air. In order to experience the full effects of the noises in boilermaking, one must ensconce himself in one of the smaller interior chambers such as a "superheater," or flue, where the air-space is still more confined, while the plates which are being hammered are thin, and therefore give forth notes not only intensely loud but extremely shrill. Even men whose hearing has been blunted by years of exposure to the sounds of boilermaking are, I am told, forced in such circumstances to protect their ears with cotton-waste or such-like stopping. Amid the overpowering din, communications have generally to be made by pantomimic gestures, and when the foreman wishes to attract the attention of the men, he employs a shrill whistle like a policeman's. When my conductor at one moment, in the loudest and shrillest voice, spoke closely into the passage of my ear, the effect was not that of spoken intelligible words but that of acute pain as the sharp tones pierced my ear. No doubt this necessity for occasionally speaking loudly close into the ear must tend also to injure the hearing of these men.

I had the curiosity to take a phonograph into the interior of a flue while the riveters and caulkers were hard at work without and within. The manipulation of the phonograph in that situation was a somewhat difficult proceeding. The results were not very satisfactory, for, while quite distinct indentations were produced upon the tinfoil, the reproduction of the sound was not effective. The indentations were small and closely arranged, indicating the great height of pitch of the notes, and contrasting with the large widely separated indentations caused by the human voice.

My enquiry included the examination of 120 men who were

employed in boilermakers' sheds, but 20 of these being labourers who were not constantly working at the trade, I have excluded them, and have based my conclusions only on the examination of the 100 men who were directly engaged in the process of boiler-making. For the facilities kindly granted to me in the course of my investigations, I have to express my gratitude to my friend Mr. Kinghorn of the London and Glasgow Shipbuilding Company, to Mr. Kirk of Messrs. R. Napier & Sons, and to Mr. Jeffrey of Messrs. J. & J. Thomson.

The 100 men examined represented all ages, from 17 years, the youngest, to 67, the oldest. The average age was 34·93. The most serious results were found, as might have been expected, in the older men. The following shows the relative numbers at the various periods of life:—

Under 20 years,	-	-	-	-	-	10
From 20 to 30,	-	-	-	-	-	27
,, 30 to 40,	-	-	-	-	-	21
,, 40 to 50,	-	-	-	-	-	28
,, 50 to 60,	-	-	-	-	-	10
,, 60 to 70,	-	-	-	-	-	4
						—
						100

The average number of years during which they had been exposed to the sounds of boilermaking was $17\frac{1}{2}$; the oldest had been at the trade for 54 years, and the youngest for three years.

The range of the enquiry embraced the four following points:—

- 1st.—Extent of the loss of hearing.
- 2nd.—Region of the Ear affected.
- 3rd.—Course of the deafness.
- 4th.—Prevention of the deafness.

I.—THE EXTENT OF THE LOSS OF HEARING.

This was determined by testing the air-conduction of sound, as in ordinary hearing, that is, when the waves of sound enter the outer canal of the ear, and are transmitted by way of the tympanum to the fluid of the labyrinth in the inner ear.

The following points were investigated:—

1. The power of hearing a simple tone such as the tick of a watch.

2. The power of hearing speech.

- (a.) Whisper at a yard distance.
- (b.) Moderately loud voice at a yard distance.
- (c.) Voice of a public speaker.

1. *The power of hearing a simple tone, such as the tick of a watch.*

I first tested the distance at which the tick of a watch was heard, the watch in question being heard when the hearing is normal 36 inches from the ear. The distance was accurately measured in each case with a measuring rule. The following table presents a view of the various results of this enquiry:—

- | |
|--|
| 15 did not hear the watch in either ear on pressure. |
| 13 heard on pressure in one ear and not at all in the other ear. |
| 21 heard when the watch was in contact with, or pressed upon the ears. |
| 15 heard in one ear only on pressure or contact, and in the other at a distance varying in different men from half an inch to 20 inches. |
| 25 heard the watch on both sides at distances varying from half an inch to 10 inches. |
| 11 heard at varying distances of from 5 to 34 inches from the ear. |

100

In no single instance was the hearing normal so far as the tick of a watch was concerned. In about half the number of men, the watch was either not heard at all, or only on pressure or contact. The nearest to the normal was 34 inches and that was limited to one man and to one ear. Perhaps a more striking way of representing the extent of the loss of hearing in these 100 men, is to sum up the total number of inches at which the watch was heard by all the men, and then compare the result with the total number at which it should be heard by 100 men having perfectly normal hearing. The total number in normal hearing is found by multiplying the double of 36 inches (for the 2 ears) that is 72 by 100; this gives 7,200, which we shall regard as the standard number of inches at which the watch should be heard by 100 men with normal hearing. The total number heard by the 100 boilermakers was 704 inches, or only 9·36 per cent. of the normal hearing.

In order to draw a comparison between the hearing of these men and that of some other classes of the community, I have examined also 100 ironmoulders and 100 letter-carriers with reference to their powers of hearing.

Through the kindness of Mr. Campbell of the Hyde Park Foundry, and of Mr. Dawson of the General Post Office, I have been enabled to carry out these examinations. The ironmoulders are not especially exposed to very loud sounds, but their ears are menaced from another direction—namely, through the nasal passages. The middle ear which is the seat of most of the diseases of the ear, is really an offshoot from the nasal passage, the lining of which, in ironmoulders must almost constantly be coated with irritating dust and dirt. Besides, their exposure to great extremes of temperature must, by exciting nasal catarrhs, still further contribute to an unhealthy state of their nasal mucous membrane. Such an unhealthy state is very ready to invade the middle ear. We would therefore expect a small sum total of hearing for ironmoulders. Letter-carriers, on the other hand, from the comparatively healthy nature of their employment, enjoying, as they do, so much of the fresh open air, may be looked upon as living under circumstances pretty favourable to a healthy state of the organ of hearing. The following numbers give the results of the application of the hearing test with the watch to these 300 letter-carriers, ironmoulders, and boilermakers, including 600 ears :—

Total number of inches at which the tick of a watch should be heard by	
100 Men having normal hearing,	7,200.
100 Letter-carriers (average age 30 yrs.) heard 5,694 or 79% of normal hearing.	
100 Ironmoulders (, 37½,) heard 3,291 , 45¾% , , ,	
100 Boilermakers (, 35 ,) heard 704 , 91% , , ,	

2. *The power of hearing speech:*—

In addition to the watch I also tested the hearing of these 100 boilermakers, with the voice. It is important, in order to form an accurate notion of the state of the hearing, not to limit oneself to such a test as the tick of a watch, or other such simple mechanical sound. There is not unfrequently in deafness a strange disparity between the power of hearing a watch and the power of hearing the voice. We meet with persons who hear the watch very badly, perhaps no farther off than an inch from either ear, and yet they hear quiet conversation so well, that their friends do not observe any defect of the hearing. We meet with others, on the contrary, who hear the watch as far as 20 inches

from the ear, and yet they require a loud voice pretty near to the ear in order to hear so as to understand. One of the iron-moulders whom I examined presented this peculiarity very markedly. When I proceeded to apply the test of the watch, he said, "You need not try the left ear, for the hearing is quite gone on that side, I only hear with the right ear." On testing with the watch, however, I found, to the man's surprise that he heard its tick 3 inches from the left ear where he said there was no hearing, while on the right side, to which he believed his hearing was entirely limited, the watch was not heard at all even on pressure. When I tried him by means of speech, however, his first statement was found to be quite correct; he could hear speech only with the ear which did not hear the tick of a watch. In testing by speech I employed—

(a) A whisper at a yard distance, using such words as "twenty," "brother," "America," "forty," "house," "garden."—The use of isolated words is a more reliable method than that of complete sentences, as in the latter, the element of guessing disturbs the result.

In normal hearing, a whisper should be heard about 22 yards from the ear. At a yard distant from the ear it was found that *fifty-nine* men could not hear a whisper with either ear, or heard it very indistinctly; that *thirty-three* men heard it on both sides; while *eight* men heard it with one ear, but not with the other.

(b) A loud-spoken voice at a yard distance.—In normal hearing such a voice should probably be heard about 100 yards from the ear. *Thirteen* men did not hear so as to understand with either ear. *Ten* men heard on one side, but not on the other. *Seventy-seven* men heard such a voice at a yard's distance with both ears.

(c) A public speaker.—This particular form of enquiry, namely, as to their power of hearing a public speaker, seemed to me a pretty reliable way of ascertaining the extent to which the deafness of these men interfered practically with their social comfort or usefulness. *Twenty-one* men stated that they could not hear so as to understand any public speaker, however near they placed themselves to the platform or pulpit, hence they rarely or never entered a church or public meeting. *Fifty-four* men stated that they heard with difficulty in a church or at a public meeting, requiring to be near to the speaker, who must also be clear and distinct. Even in these favourable circumstances, they missed

much of what was said. Only *twenty-five* asserted that they had no difficulty in hearing in whatever part of the hall or church they were placed.

Of the hundred ironmoulders whom I examined, *twelve* stated that they had difficulty in hearing in church or public meeting; while of the hundred letter-carriers, *eight* assured me that they heard with difficulty in church or public meeting.

I think these facts should be considered by those interested in the religious and social welfare of the people, and especially by public speakers and clergymen. I have been informed that two thousand five hundred men are probably actually engaged in this trade in Glasgow and its neighbourhood, besides those who may have left the trade, after having had their ears injured by the noise, and those labourers who are more or less associated with the same noisy work. Twenty-one per cent. of these are, as we have seen, practically debarred from church or public meeting; and although, no doubt, some excellent men, notwithstanding that they themselves hear nothing, attend church regularly for the sake of example to others, yet such are, I fear, few; while fifty-four per cent. are very much hampered in their enjoyment of church or public meeting owing to defective hearing. It might be worthy of consideration whether there should not be some arrangement made in the interests of boilermakers, so that this serious defect might be met by providing them with small places of worship, having good acoustic qualities, and supplied with speakers possessed of a strong voice and clear articulation. In the large, lofty ecclesiastical edifices which adorn our city, in the design or construction of which the question of hearing is, I fear, sometimes neglected in the calculations of the architect, the poor deaf boilermaker has no chance. Apart, however, from boilermakers, the results of my examination of ironmoulders and letter-carriers—and these results bear out my observations of other classes—show that in the community there is a surprisingly large number who are more or less dull of hearing. Probably we are not far off the mark when we say that in every congregation or public meeting numbering 500 persons, 50 of these have some impairment of hearing. And of these 50 it may be said that if the speaker has not a clear and distinct mode of articulation, if he is not possessed of a fairly strong voice, they hear with difficulty, and do not follow the speaker with ease and advantage. When we consider that, owing to the strain of listening and the feeling

that they are missing portions of what is said by the speaker, they soon become tired and discouraged in their efforts, and are apt to fall into a state of listlessness and inattention, it is not surprising that such persons are much tempted to remain at home. If my words reach any one destined for the clerical profession, or aspiring to success as a public speaker, I would urge him, in addition to his mental training, not to omit attention to the medium by which his mind has to communicate with the minds of his hearers—namely, the mechanical act of speech—I would urge him to cultivate such qualities as strength of voice, slowness, clearness, and distinctness of articulation, to avoid slurring over the consonant sounds, and the bad habit of lowering the voice at certain parts to an almost inaudible tone, last of all, to eschew, if possible, moustache and beard. These appendages are, I assure him, serious hindrances to the efforts which all persons who are dull of hearing instinctively make to read the facial movements of a speaker. Deaf ladies who wish to conceal their infirmity shun the society of moustached and bearded men. The reading of the lip and facial movements is universally practised by deaf people, and is a great help to them in understanding speech. I know persons who, when they visit the theatre, understand nothing of what is said on the stage until they have the face of the actor well in the field of an opera-glass. Hence, good vision is a great help to a deaf person—hence, also, the face of a public speaker should be well illuminated. In many pulpits there should be more light. Deaf persons hardly know their dependence upon their vision, and complain that their deafness is worse at twilight, not observing that their deficiency is aggravated by their imperfect vision.

A clergyman, therefore, cannot ignore the members of his congregation who are dull of hearing with safety to his reputation or popularity. I find that persons dull of hearing generally attribute their difficulty in hearing to the defects of the speaker's voice and articulation. In the privacy of my consulting room they often dilate very bitterly on the subject of "poor speakers." On the other hand, when they do make out fairly well what a speaker says, they are profuse and cordial in their expression of praise of the speaker. I may say, in this connection, that it is frequently the chief regret of a deaf patient that he or she cannot now hear the minister. I trust the minister will co-operate with the surgeon in assisting the deaf to hear.

II.—REGION OF THE EAR AFFECTED.

We now come to the consideration of what region of the organ of hearing is affected in persons exposed to loud noises. This necessitated the study of the following points :—

1. Bone-conduction of sound (when a sounding body is applied to the head).
 - (a) Watch on temple.
 - (b) Tuning-fork behind ear.
2. The power of perceiving notes of high pitch.
3. Hearing better in a noise.
4. Noises in the ear.
5. Giddiness.

1. *Bone-conduction of Sound.*—Supposing the ears were sealed up so that sound could not find admission by these channels, if a tuning-fork were made to vibrate, no sound would be heard, provided a space of air, however small, existed between the head and the fork. The waves of sound falling upon the head from the air would not be sufficient to throw the cranial bones into vibration, they would in great part be reflected from the surface of the head. But place the vibrating tuning-fork in contact with the head and its note would be heard resounding even more loudly than if the ears were open. In this case the vibrations of the tuning-fork are communicated to the bones of the head, and are transmitted to the osseous casing of the cavities of the ears, from which they pass to the endings of the auditory nerve in the labyrinth—this is what is termed *bone-conduction of sound*.

With the ears open, this mode of conduction is somewhat feebler than the ordinary method of hearing through the air. For we find that after a vibrating tuning-fork placed in contact with any part of the head has ceased to be heard, it will again become audible if transferred to a point opposite to, but not touching, the orifice of the ear. In a normal state of the hearing, therefore, sound waves conducted to the nerve of hearing by the bones produce a less effect than when conducted by the air. But, curiously, with many deaf people this is often reversed, and they hear much better by the bone-conduction. Without entering upon the more exact details of this matter, which would divert us too far from our proper subject, I will just say that as a general rule, liable, however, to exceptions, when in a deaf person the

bone-conduction excites the nerve more readily than the air-conduction, we conclude that the obstacle to hearing exists in the parts of the ear external to the labyrinth—that is, in the outer ear or middle ear, the so-called conducting apparatus of the ear. When, on the other hand, in a deaf person, the air-conduction produces a greater effect on the nerve than the bone-conduction (the condition in health) we infer, although this is subject to more numerous exceptions than the other, that the labyrinth or nervous apparatus is the seat of the mischief.

In each of these hundred men, therefore, I tested the relationship between the bone-conduction and the air-conduction of sound.

For this purpose I employed a loudly ticking watch and a tuning-fork. In testing with the former, the watch was pressed upon both temples. The watch is only suitable where the deafness is very decided, otherwise it is heard by air-conduction as well as by bone-conduction, although placed on the bone, and this disturbs the result. It was thus applicable in 133 ears. In only 13 of these ears was it heard by bone-conduction, and thus in 120 ears the presumption was that some obstacle to hearing existed in the nerve structures. But the use of the vibrating tuning-fork yields the best results. In the case of each man I applied the vibrating tuning-fork (C) to the mastoid process, that is, the smooth bulging behind the ear; and when the sound had completely died away on that part, I instantly transferred it to a point opposite to, but not touching, the orifice of the ear. In 90 of the men the sound was audible for some time in the latter position after it had died away in the former. In these 90 deaf men, therefore, the bone-conduction was feeble as compared with the air-conduction, thus pointing to the nerve structures as the seat of the lesion. I employed likewise a second experiment as a confirmatory test. In each of these 90 men, after the sound had ceased on the mastoid process, I quickly transferred the tuning-fork to my own mastoid process (and I may say that I have reason to believe that my auditory apparatus is normal), and found that in every case the sound was heard by me for some time after it had ceased to be heard by the man under examination. This again proved defective bone-conduction, pointing still to diminished nerve perception. In the remaining 10 persons, representing 12 ears, the opposite results were found, the tuning-fork being heard for a longer time by bone—than by air—conduction. In these exceptional cases, both with reference to the tuning-fork and the watch, there was

probably, in addition to the nerve lesion, some morbid state of the conducting apparatus, which, by intensifying the bone-conduction, compensated for the diminished perception of the nerve.

2. *Power of perceiving notes of high pitch.*—In connection with tests applied to the nervous structures of the ear, I examined twenty of the men with special reference to their power of perceiving tones of high pitch. The sounds in boilermaking which are probably most injurious to the ears are the notes which are extremely shrill, and which act with most damaging effect upon the short fibres of the basilar membrane in the cochlea—these short fibres being concerned especially in the perception of high pitch. For producing varieties of pitch, I employed a Galton's whistle, which consists of a silver tube about 2 cm. long, with a bore of 1 mm. Notes of various pitches are produced by altering the length of the tube by means of a piston which can slide in the tube. The more deeply the piston is pressed, the shorter the tube and the higher the notes. Notes from about 9,000 (9 mm.) vibrations to 28,000 (3 mm.) vibrations may be sounded in this way. Of the twenty men examined with the whistle I found the power of perceiving high notes strikingly diminished in every case. Above 9,000 vibrations per second the hearing gradually diminished, and few could hear 20,000, and then only very faintly. In health, it may be mentioned, the power of perceiving tones of high pitch is greater, as a rule, within limits, than that of perceiving tones of low pitch. In persons with normal hearing, notes as high as from 40,000 to 50,000 vibrations per second may be perceived.

3. *Hearing better in a noise.*—Another interesting point was made the subject of enquiry in these 100 men, namely, whether they heard speech better in the midst of a loud noise or during perfect quietness. It is a remarkable fact that many persons with very defective hearing hear better in a great noise, such as in a railway carriage, or in the presence of noisy machinery, than in a quiet place. The instance of this peculiarity first described was that of a husband who could be heard by his deaf wife only while the servant was beating a drum. Some try to explain such an apparent paradox, by pointing out that in a railway carriage the confined space, the nearness to the speaker, the elevation of the voice, and the close attention of the listener, may account for the apparently better hearing. The elevation of the speaker's voice must be taken in conjunction with the important fact that the general noise is not impeding the deaf

person's hearing as it is that of the normal subject. He is, so to speak, profiting by the loudness of the voice while he is not disturbed or distracted by the din around him. While I was travelling lately along with a friend afflicted with deafness, in a steamboat on the Clyde, my friend remarked that he rejoiced when the steamboat whistle brayed forth, because then the speaker raised his voice and his deafness was hardly detected. Nevertheless, it is unquestionable that, apart from these modifying influences, the hearing, in the case of some deaf persons, is actually improved in the presence of loud noises. The explanation, probably, is that in such cases the three small bones of the ear have become stiff and rigid, and have lost their wonderfully delicate powers of vibration in response to waves of sound, of moderate intensity, striking upon the tympanic membrane. When, however, they are shaken by strong coarse vibrations entering the ears, they are thereby, it may be conceived, rendered fit for the time being for transmitting ordinary vibrations from the human voice.

In regard to the men under examination, with a few exceptions, they reported that they heard better in *quietness*. On questioning carefully the few who asserted that they heard better in a noise I was satisfied that the peculiarity could be explained by the circumstances already mentioned, especially by the loudness of the voice, and the proximity of the speaker. If the explanation just offered of the cause of hearing better in a noise is a correct one, the absence of this phenomenon noticed in these men still further corroborates the view that the nerve structures are the seat of the lesion.

4. *Noises in the Ears.*—This is a very common symptom in the various diseases of the ear, in many of which indeed it is the main feature, and in a small number the only symptom for which relief is sought. I have been surprised at its comparative infrequency in these men. Only 8 men seemed to suffer permanently from these noises, and even in these the sensations were not of a distressing character. Thirty-four men, however, mentioned that they had at times noises in the ears; they were experienced chiefly after getting home at night, but were gone in the morning, or they were only present when they suffered from a cold. For a time after joining the trade, most apprentices are troubled with a sounding in the ears every evening for a few hours after leaving work. This comparative absence of persistent noises in the ears

of these men is in marked contrast with any 100 cases of ear disease which are treated at our Hospitals. For example, of 100 consecutive cases of ear disease affecting the conducting apparatus of hearing, treated at the Glasgow Ear Hospital, 78 were attended by a constant noise in the ear. Noises in the ear are probably in most cases due to pressure exerted directly or indirectly upon the terminal nerve structures in the labyrinth from causes external to the nerve, while the mischief in the boilermakers is probably of the nature of a degeneration of the nerve structures themselves.

5. *Giddiness* is now well recognised as a pretty frequent symptom of ear disease, being probably due, as in the case of noises in the ear, to pressure upon the nerve structures. Only one man stated that he had such severe giddiness as to amount to attacks of staggering, the attacks, not continuing for any length of time, and separated from one another by considerable intervals. In other fourteen men there seemed to be occasionally when stooping, or in the morning, when rising out of bed, some sensation of giddiness. But I attributed little importance to these sensations in their bearing upon the state of their ears. It may be said, then, that noises in the ear and giddiness have not been met with in anything like the frequency found in cases of ear disease attended by a like amount of impairment of hearing, when due to disease of the conducting apparatus of the ear.

In regard, therefore, to the question of the region of the ear affected when the organ is exposed to loud sounds, such as in boiler-making, the great preponderance of evidence (derived from the state of the bone-conduction, the diminished power of perceiving high notes, and the study of certain other symptoms) points to the *terminal nerve structures, probably in connection with the Basilar membrane of the cochlea*, as essentially the seat of the mischief. There is no doubt, however, that in a certain proportion of cases, disease likewise exists in the middle and external ears, modifying the symptoms, just as disease of these parts exists in a certain number of all classes of the community.

III.—THE COURSE OF THE DEAFNESS.

In regard to the length of time intervening between their entrance upon the noisy employment and the commencement of the disturbance of hearing it was not easy to obtain accurate information. The statements of the men as to the duration of their deafness generally refer only to the time during which the loss of hearing had

markedly attracted their attention. When closely questioned, most of them admitted that a certain degree of disturbance of their hearing began almost immediately after entering upon this kind of work, advancing in many cases slowly, but in some much more speedily to very decided deafness. When apprentice lads, with the keen sensitiveness of hearing which often characterises the young, are first put into these boilers, they are quite "stunned." The following descriptive terms were used in answer to the question how the noise first affected their ears:—"Bad," "very bad," "awfully bad," "fearful," "could hardly stand it," and I am not surprised, from my own experience of the sound, to be informed that a number who enter upon this trade cannot stand it, and have to abandon it in favour of some other kind of employment. These apprentices said that even from the first they feel dull of hearing at night, and have a sensation of buzzing or confused din in their ears; these feelings, however, usually pass away in the course of a few hours, and on the following morning they feel quite well again. A few hours of absence from the noise apparently suffice at first to enable the irritated nerve structures to recover themselves. After a few weeks, or it may be months, if they are able to continue at the work, they appear to get accustomed, as they express it, to the noise; more correctly they have now diminished perception, probably due to partial paralysis of the nerve structures in the cochlea, and they become gradually less and less painfully and disagreeably affected by the noise. Some of the men went the length of asserting that they had reached such a state of torpidity to the sound as to be able to sleep in the interior of a boiler while all the riveters and caulkers were at work. Some, on the other hand, never reached the happy stage of being indifferent to the noises, and always felt it very unpleasant, even painful, when they had to work in the interior of a boiler, and they tried to avoid it. A number of the men mentioned how doubly painful the sensation was when, in consequence of the plates being thin, the sounds were of an extremely shrill character. I have mentioned that at first the dulness and noises in the ears pass off after a few hours of quietness. I found also, that even in after years when their hearing was markedly impaired, many of them thought that it improved when they were idle for a week or two, as at a holiday time. There seemed to be truth in these statements, for in a few cases where I was surprised at the comparatively small loss of hearing in men who had

been long at the trade, I discovered, on enquiry, that they had at some time been absent from the trade for a year or two, perhaps away on a long voyage working on board ship. A number, however, stated that their hearing was not improved in the least by a period of absence from the noise.

The changes, therefore, which are produced upon the ear by the action of these loud noises seem always to tend at the earlier periods to pass away simply under the influence of rest to the organ; and even in the advanced stages there is frequently a tendency to distinct improvement on the removal of the irritating cause.

IV.—PREVENTION OF THE DEAFNESS.

The only other subject embraced in this investigation was as to the use by the men of means for shutting out the sound and protecting the ear. In answer to my enquiries, 28 men stated that they occasionally stopped up their ears with cotton or some such substance. Most of these only used such a preventive when they were working in the interior of a boiler while riveters were hammering outside, especially when they were put into a smaller cavity, such as a flue or "superheater." It was used in these circumstances, not with the object of preventing deafness, but to diminish the painful sensation experienced at the time in their ears. When severe dulness of hearing comes on, and the sensation is neither so painful nor so disagreeable, they usually discard the cotton plug. Most of the men seemed to be prejudiced against cotton plugs, chiefly owing to the notion that the use of cotton might make them liable to catch cold when they removed it at night; some, however, objected to this precaution because it interfered with their hearing, and others because it excited a disagreeable itchiness in the ear. But the main reasons for the neglect of such precautions were, I fear, want of appreciation of the value of hearing, want of forethought, and the conviction that dulness of hearing is an inevitable consequence of this kind of work. Speaking for myself, the interior of a boiler was quite intolerable unless my ears were plugged with India-rubber plugs, such as I show you here. When they were inserted in the orifices of my ears I was able with impunity to remain inside a flue while using the phonograph, although the noise was at its very worst. I observed, while the plugs were in my ears, that I was able to hear the voice of a speaker better than when the ears were open. Apparently, the

dulling effects of closing the ears were more than compensated by the shutting out of the terrible and deafening clang. These plugs, which are hollow, and made of various shapes and sizes to suit various ears, were introduced by Mr. Cousins, of Southsea, and were originally intended for bathers in order to protect the drums of their ears when diving, and for this purpose they are very useful. As prepared by Mr. Cousins they are round, but I have, with his sanction, had such plugs made elliptical and oval in shape, which accords better with the form of the lumen of the orifice of the ear. I tried these plugs with some of the men both in the works of Messrs. Napier and of the London and Glasgow Shipbuilding Co. and they have so far reported favourably. They agree with me that they rather favour the hearing of speech than otherwise. In order to avoid irritating the canal of the ear, they should not be too large, and should be smeared with vaseline, which renders them effective in keeping out the sound without the necessity for very tight plugging. A plug of cotton well smeared with vaseline was, at my suggestion, also tried by some of the men. When the cotton is in the ear I found the sharp painful character of the sound was materially modified, giving place to a dull thud not particularly disagreeable. The India-rubber plugs are, however, more handy and effective. It would be well if apprentices when entering upon this kind of work were advised by the foreman to use such simple precautions for protecting the ears, for by these means it is probable that the injurious effects produced upon the ears by the intensely shrill notes would be materially obviated, while the protection which they would afford against the actually painful influences of the terrible din would prove a great comfort to the men.

Let me, in concluding, recapitulate the chief results of these enquiries :—

1. No one engaged in boilermaking for any length of time escapes injury to the hearing.
2. In about half the number of boilermakers the hearing power is so defective that the tick of a watch, which should be heard 36 inches from the ear, is either not heard at all or only on contact with the ear.
3. As compared with the normal standard, they possess only about $9\frac{1}{3}$ per cent. of hearing power.
4. As compared with men engaged in other occupations, their hearing power is extremely defective—for example, letter-

- carriers have 79 per cent., and even ironmoulders 45 per cent. of the normal hearing power.
5. The extent of their defective hearing is also strikingly shown by the fact that three-fourths of their number could either not hear at all at a public meeting, or heard with difficulty.
 6. In regard to the ironmoulders, 12 per cent. admitted difficulty in hearing in a public meeting, while of the letter-carriers 8 per cent. admitted the same difficulty.
 7. In view of the fact that probably of those who attend church or public meeting 10 per cent. hear with some difficulty, it is of great importance that clergymen and public speakers should cultivate clearness and distinctness of articulation.
 8. There is almost decisive evidence in favour of the view that the nervous structures of the inner ear are essentially the seat of the mischief in boilermakers' deafness. This evidence is derived mainly from the weak conduction of sound by the bones and the defective perception of tones of high pitch; but other peculiarities in regard to such symptoms as hearing better in a noise, noises in the ear, and giddiness, also support this view.
 9. Lads when they join the business experience very painful sensations in the ear, and there is little doubt that the hearing power begins to suffer very soon after.
 10. There is a tendency, at all events in the earlier stages, for the disturbance of hearing to diminish or pass away simply under the influence of absence from the noise, and even in the advanced stages there is sometimes a similar tendency.
 11. The men have hitherto employed preventives in the form of cotton plugs, mainly in special and temporary circumstances.
 12. Men who have recently joined the trade, and also many older men in whom the noises produce painful symptoms, would gladly employ some simple and efficient preventive or sound-deadener.
 13. The india-rubber hollow cushion or plug promises to be useful, both for alleviating the painful effects of the noises, especially inside the boilers, and preventing the ultimate deafness.

XIX.—*The Riches of the Sea.* By C. A. SAHLSTRÖM, of the
Normal Company, Aberdeen.

[Read before the Society, 17th March, 1886.]

THERE are probably few matters deserving a more careful consideration than the means by which the inexhaustible riches of the ocean may be turned to account, and made to serve a wider range of useful purposes than those very restricted objects to which they have hitherto been thought to be adapted. In studying the statistics of Fisheries, one cannot but feel surprised at the disproportion existing between the enormous quantity of products yearly drawn from the sea, and the actual income they yield. This disproportion becomes all the more apparent on examining the gains obtainable from industrial pursuits, which, despite their relatively smaller resources, are nevertheless immeasurably more remunerative than the fishing industry. Have, then, the products of the ocean so small a value that they merely enable the toiler to gain a poor, miserable pittance as the reward of his labour and risks? or, rather, does not the ocean teem with treasures, which, rightly utilised, would transform their pursuit from a calling of penury to one of well-assured profit to all engaged in it?

The history of every new advance in civilisation is the story of some hard-won conquest over nature's materials and forces—of successful efforts to discover and adapt their several capacities to human wants. Every such conquest widens the gulf that separates the present from the past with a completeness that mere lapse of time could never accomplish, as we see in the case of China, whose strangely arrested progress leaves her to-day exactly where she was five thousand years ago. Fortunately, each step forward makes the following one the easier. Each new discovery creates innumerable fresh wants, each one of which in its turn calls into active life and vigour the innate energy and genius of man; thus civilisation makes ever increasing claims on life, and what our ancestors regarded as the *ultima Thule* of industrial art, our refined age looks upon as rude and simple. As a natural consequence,

a greater perfection and adaptability are given to almost all products, which consequently attain a higher value, and thus contribute to the well-being and prosperity of the race.

In following the development of fishing industries, one is struck with its one-sidedness. While no pains have been spared to improve fishing tackle, hatching establishments, and in fact everything that contributes to an increase of the harvests of the deep, the fish itself, with but few exceptions, is treated and utilised in the same manner now as it was hundreds of years ago. Of the truth of this assertion we had ample proofs at the Fisheries Exhibitions in Berlin and London.

Are, then, the present methods of utilising and preserving fish so perfect that no improvements are necessary or even possible? One is almost led to believe that such is the case, in view of their total neglect at the hands of the modern pioneers in the paths of progress and civilisation. Yet these are important questions, claiming serious attention, and presenting a field so full of good promise that hardly anything in our day can compare with it. Take, for instance, the enormous quantities of what is generally called "offal" that accumulate at places where fish is cured, and consider its utility. Every reflecting person will no doubt perceive the loss such waste of valuable products is to the community at large as well as to the individual owner. In addition to the fact that the throwing away of a useful thing has a demoralising effect, these putrid masses are exceedingly dangerous, and largely contribute to the spread of illness and epidemic disease, of which the dreadful outbreak along the Volga, due to the mephitical vapours from fish offal, is a striking example.

Nature does not know anything about "offal," the word is merely an expression originating from ignorance and idleness.

In America and a few other places the manufacture of guano from part of the fish offal is already considered an important step towards the amelioration of this evil.

In his report on the International Fisheries Exhibition in London, Sir Spencer Walpole makes the following remarks on this question (vol. xiii., p. 131):—

"In Britain such minor matters as the use of refuse seem to escape attention; but the race for wealth is so keen, the struggle is so bitter, that it is high time to look after even little profits. Take the case of herring-fishery alone:—If 1,000,000,000 herrings are annually cured, and the refuse of each herring only weighs one ounce, 1,000,000,000 ounces, 62,500,000

lbs., or nearly 30,000 tons of refuse are annually thrown away. Can we afford to go on wasting such a source of wealth, which, if it were used, would add to the profits of the fisherman and the industries of the nation?"

Besides the manufacture of guano from refuse, other and more valuable products can be obtained from part of it, such as fish glue and isinglass. The latter product was already known by the cultured Greeks of old by the name of "Ichthyocolla," and is often mentioned by such writers as Dioscorides and Pliny.

It is considered tolerably certain that fish glue constituted an important part of the lacquer so skilfully prepared by the ancient Chinese—an industry which the inventive faculty of to-day has not succeeded in imitating.

Some fish possess a peculiar kind of organ specially adapted to the element in which they move. It is through the contraction and expansion of the "sound" that these fishes are able to raise and lower themselves in the water. With certain kinds, such as *Acipenser Huso*, *Ac. Ruthenus L.*, *Ac. Stellatus*, and a few of the *Gadus* species, the "sound" is thicker and possesses a larger percentage of glue, thereby making it more valuable for the manufacture of isinglass. Experience has, however, shown that the "sounds" of other fish can also be used with advantage; and seeing that the best Astracan isinglass realises from 15s. to 20s. per lb., the subject is well worth paying attention to.

Avaling ourselves of the valuable statements made by His Royal Highness the Duke of Edinburgh respecting the value of trawled fish, we find it to be £12 per ton, and calculating the average weight of cod or ling at about 9 lbs., the value of 1,500 fishes would be £72. 1,500 fish bladders are required for the manufacture of 100 lbs. of isinglass. Calculating the selling price at only £10 per 100 lbs., it still shows that the utilisation, in a proper way, of this apparently valueless raw material represents 13·9 per cent. of the value of the whole fish.

From the annual statement of the trade of the United Kingdom, we find that the average yearly importation of isinglass during the last five years has been 6,737 cwts. It is therefore easily seen that the importation of this article might be greatly diminished and made good by home-made isinglass.

To use the other parts of the fish for producing glue has long been a subject of elaborate and exhaustive experiments, without, however, any success being achieved worth mentioning. The flesh of the fish contains many salts which cause a high degree of

impurity in the glue, and consequently render it more or less unsuitable for manufacturing of adhesive substances. The methods hitherto suggested for removing the difficulty are exceedingly complicated and impracticable.

Since the "skinned and boneless cod" was introduced into the market, a large quantity of fish skins became obtainable, and of these Mr. Le Page in America has availed himself for the manufacture of his "Russian Cement." In Gloucester, U.S.A., alone, from 2,500 to 3,000 tons of this raw material are annually used for making glue, for which 15 dollars per ton is paid for the raw material on the spot.

The more fish glue came to be used the more were the public convinced of its advantages over any other animal glue where tenacity and elasticity had to be considered.

The demand for the former is now so great that the limited supply of the raw material (fish skins) is not sufficient to meet it. According to the Normal Company's patented processes, glue can, however, now be manufactured from almost every part of the fish, and by carefully sorting them, and using at one time only those that are of a similar nature, different kinds of glue can be obtained, especially adapted to different purposes.

As "skinned and boneless cod" has not as yet been prepared in Great Britain and Ireland, fish skins in any quantity are, of course, not obtainable here. The practical experiments which the Normal Company, Limited, has for some time carried out have fully demonstrated that a fish glue of superior quality can also be made from substances other than fish skins, and the raw material for this article being obtainable in immense quantities both in Scotland, England, and Ireland, as well as in any other country where fishing industries are carried on, the manufacture of fish glue of the very best quality may be developed into a native industry of a peculiarly lucrative character.

As an illustration of the great tenacity of this cement the following experiment may be cited:—A quantity of the fish glue was poured over a thick glass disc to dry. Attempts to remove the glue by sheer force were only successful when numberless fragments of glass had been actually torn out of the disc, thus establishing the remarkable fact that the Normal fish glue possesses an adhesive power greater even than the cohesive power of glass itself. For the manufacture of fish glue, certain parts of the fish, or the fish in its entirety, may be used, but the products obtained

as well as the percentage varies of course according to the quality of the raw material.

According to the statistics furnished by His Royal Highness the Duke of Edinburgh, the quantity of fish caught by trawlers in one year was as follows:—

English trawlers,	- - - -	211,707 tons.
Scotch	,,	762 ,,
Irish	,,	2,688 ,,
Total,	- - -	215,157 tons.

According to the same authority, the line fishermen of the United Kingdom make an annual catch of 51,000 tons of fish, thus giving a total catch of 266,157 tons, which, at £12 per ton, represents in round numbers an aggregate value of £3,200,000. Calculating that the heads, bones, and entrails amount to 30 per cent. of the total weight, the "offal" or refuse would amount to 79,847 tons. If this refuse were utilised for glue and guano the calculation would show in round numbers—

5 per cent. Fish Glue,	- - - -	3,990 tons.
33 per cent. Guano,	- - - -	26,350 ,,

Estimating the value of the glue at only sixpence per lb., and the guano at £8 per ton, we arrive at £434,240 as the total value of the above products—or rather more than 13·5 per cent. of the entire value of the fish.

We pointed out above, that cod and ling yield isinglass to the amount of 13·9 per cent. of their whole value. Hence the three products referred to, namely, glue, guano, and isinglass together constitute 27 per cent. of the entire value of the fish.

This estimate is in itself sufficient to demonstrate that the business of the fishermen affords a field of enterprise from which considerable profits are to be derived, at an outlay of capital and labour that will compare very favourably with the expenditure incurred in the vast number of other industries.

In order to show that the price of £8 per ton for guano is not too high an estimate, we may refer to the following analysis:—

Report on a sample of Fish Guano received May 2nd, 1882, by H. A. Carpenter, F.C.S., F.R.M.S.—

Total phosphoric acid,	- - - -	14·76 per cent.
Equal to tricalcic phosphate, bone phosphate,	-	32·21 ,,
Total nitrogen,	- - - -	10·75 ,,
Equal to ammonia,	- - - -	12·84 ,,

The Metropolitan Laboratory.

23 Holborn Viaduct, London, E.C..

May 6th, 1882.

ALBUMEN.

Albumen is a product of great importance to the industrial arts. It has hitherto been produced exclusively from the white of eggs or from blood. But as both of these raw materials are expensive and comparatively difficult to get in any considerable quantities, the cost of its manufacture is enhanced in a corresponding degree; hence efforts have been made to produce a cheaper albumen from less costly and more accessible sources. In France, where the consumption of albumen is greater than in any other country, the manufacture of this product has been somewhat cheapened under the stimulus of the Government reward offered to inventors of a new industrial method or process for lessening the cost of production. No great advance has, however, been made in this direction, for beyond setting up poultry farms in the middle of France—on some of which 60,000 head of poultry are kept—exclusively for the manufacture of this material, nothing has been done. The business as thus conducted is, from its nature, extremely troublesome, and not unfrequently full of risks—an outbreak of disease in the poultry yard doing, possibly in one season, an amount of damage that will take years of patient toil to repair.

Assuming all to go well, it is still obvious that as about 300 eggs are required to produce about 2 lbs. of albumen, the cost to the consumer must still remain high, in spite of the valuable bye-product yielded by the yolk in its dry state.

The importance of this question of cost to the industrial interest, and the benefits that would be conferred on all concerned by any method that would facilitate the cheap production of albumen, may be inferred from the single fact that, in Alsace and Lorraine alone, the annual consumption of that material amounts to no less than about 900,000 lbs.—the product, in other words, of the whites of nearly 135,000,000 eggs. Albumen is mostly used in the application of colours to stuffs. The white coagulates at about 140° Fah., and is in this form insoluble in water, &c. From this it derives its use and value in the manufacture of ingrain washing materials. A great deal of egg-albumen is, moreover, consumed in photography and several other industries.

Albumen manufactured from blood is, on account of its darker colour, less useful than the egg-albumen, and consequently somewhat lower in price. Blood-albumen is at present manufactured at the large Slaughter-houses in South America, but even there

the comparative smallness of the supply of the raw material raises the price of this kind of albumen, middling qualities fetching from 1s. 6d. to 4s. per lb.

The manufacture of sugar is another great industry in which albumen is used, owing to its clarifying property. Pure albumen being, however, too expensive, unprepared blood is almost exclusively used here.

Those who have paid a visit to any of our sugar refineries scarcely need to be reminded, perhaps, of the unpleasant reflections called up at the sight of the vast quantities of blood which, in a state of semi-decomposition, malodorous, and alive with germs, they recognised as the instrument that was to be used in the preparation of one of their chief articles of food.

There is, however, no longer any necessity for the employment of a material which is revolting in its nature, and not a little costly to acquire.

Cheaper and equally serviceable albumen can be produced from the roe and flesh of fish.

Shortly before the spawning season, the fish roe contains a large quantity of albumen, which may without great difficulty be extracted, cleaned, and dried. According to a Norwegian statistical report, the average price of fish roe per barrel was, during the year 1868-79, estimated at about 22½ Norwegian crowns = £1 4s. 4d. The weight of one barrel of roe is about 300 lbs., and gives at least 50 lbs. of albumen. At a sale price, for instance—only 2 crowns per lb.—the albumen extract from one barrel of fish roe represents a value of about 100 crowns = £5 9s., or about four times the value of fish roe. This method of manufacturing albumen is both cheap and easy.

As fish roe, however, has already a comparatively high value in the market as an article of diet the practicability of its use for the manufacture of albumen cannot be maintained. There are, however, the enormous quantities of fish, large and small, as well as cetaceans, which, although possessing little or no value for commercial or industrial purposes, are, nevertheless, most suitable for the object in question.

The flesh of these fish contains considerable quantities of albumen, which may be extracted and cleansed so as to serve in the place of blood as a clarifying material in the refining of sugar, and to perform its due function in the application of colours to stuffs in dye-works. The raw material for the manufacture of this albumen

is obtained with little trouble, and can be made to form the basis of an industry of considerable dimensions.

CONSERVING OF FISH PRODUCTS.

The method most commonly employed for the purpose is salting, which is still pursued in much the same primitive way as when first invented hundreds of years ago, and this in spite of its generally acknowledged defectiveness. Fish contains a large proportion of air, and if even the most rational of hitherto known methods is used, viz., to pickle the fish, the air which the fish contains is still sufficient greatly to favour the decomposition of the delicate albumen.

It may, however, be truly asserted, to the great surprise probably of most consumers, that salted fish is in a state more or less of dissolution, or, to use a more terse expression, of putrefaction. This is especially noticeable in the haberdine and the stockfish, the disagreeable odour of which fully bears out this assertion. This, however, is inevitable, seeing that the fish, after having undergone a slight salting process, or sometimes none at all, is hung up on scaffolding or put out on rocks, to remain there for months exposed to all changes of weather, being one day half dry and the next soaked with rain or by the moisture from the sea, these conditions alternating for a considerable length of time.

Moreover, it suffers from the swarm of numberless sea fowls that congregate in these neighbourhoods. But, perhaps, a better idea may be formed of the damage thus caused to the fish, including that by gales, when it is pointed out that the loss in most districts is calculated at from 20 to 25 per cent. of the total quantity of the fish submitted to the process referred to.

To avoid this loss, but chiefly to prepare a perfectly fresh, and consequently a more palatable and nutritious food, is the aim of the Normal Company's process.

As in the salting of the fish, according to the methods hitherto employed, salt must be used in large quantities, the flesh becomes so impregnated with brine as to be rendered unpalatable to many people. According to the Normal Company's system, the salting can be made so slight that fish prepared in their way tastes, when cooked, perfectly fresh.

The principle on which this new method of preserving is based, is to extract the air and other gases from the newly caught fish by means of a simple mechanical apparatus, substituting for it a

solution, more or less strong, as a means of preservation, the fish being afterwards subjected to a pressure of 4 to 8 atmospheres. Fish slightly salted will, of course, not keep long, and is therefore intended for early consumption in the different markets to which it is sent. When the fish is treated on the Normal Company's system, an exceedingly small quantity of salt is required for its preservation, and this can be accomplished (if necessary) without using any chemical preparations such as salicylic acid, boracic acid, &c.

Besides the considerably smaller quantity of salt required in the Normal Company's method of salting fish, as compared with the ordinary process, the cleaning of the fish need not be done at once, but may be delayed until the more busy fishing season be over. Consequently, barrels or staves need not be carried on board for long fishing expeditions, as the fish may be prepared immediately on being drawn from the sea, and be thrown into the hold, where it can be left without risk until the return of the boats, when sorting, packing, &c., can be done.

Salted herrings may be eaten fourteen to sixteen hours after pickling, or they may be kept without brine and yet preserve their freshness, the flesh, surprising as it may seem, remaining soft and moist to the last.

We have now gone through the preservation of fish intended to be kept for a long time, and it is obvious that for this purpose much more preservative must be applied than for fish intended to be kept only for a few days. Such fish must not differ either in appearance or taste from fresh unpreserved fish. To reach this perfection of preserved fish, I might say, has, for a long time, been one of the objects of the Normal Co.'s efforts, a patent for same having been taken in 1881. The very same principles for the curing of fish intended to be kept for a long time, just described, are applicable even here, although considerable modifications and alterations must be used according to the result desired. I am glad to say that our experiments in this direction have been crowned with great success, and I think we shall be able in a cheap and simple way, without the use of injurious chemicals, to preserve fish so that it can be kept for a short time in such a way that it neither in appearance nor taste can be found different from fresh fish. An important advantage in this method is that for the packing of the fish no special vessels are needed, common barrels being quite suitable.

We will now turn our thoughts to the subject Fish as Food and beg to refer to Sir Henry Thompson's article bearing that title.

How often do we not find that even people of distinction and culture incorrectly entertain the belief that fish is not a nutritious food? In examining the analysis of the flesh of fish and mammalia, one is surprised at the great similarity in their component elements. Thus we find in the above-mentioned Sir Henry Thompson's excellent treatise the following:—

"Analysis in general terms of the composition of the flesh of a healthy animal not artificially fattened and omitting the bones.

"In 100 parts.

"About 75 to 78 are water,

"Leaving 22 , 25 solids.

"Of these solids,

"About 16 or 17 are albuminoids or flesh-forming material nitrogenous compound.

"About 1 to 2 are gelatine.

,, 2 , 4 , fat.

"Remainder, extractives and salts."

ANALYSIS OF WHITE FISH WITHOUT BONE.

(Sole, Whiting, Turbot, &c.)

In 100 parts

About 75 to 85 are water.

,, 20 , solids.

"Of these solids

About 12 to 18 are partly albuminoids, with } Nitrogenous
a large proportion of gelatine, . . . compounds.

On a still closer analysis it is found that salts and extractives also exist in about the same percentage in both the kinds of foods.

Seeing, therefore, that the composition is almost the same, fish may properly take equal rank as an article of food with the more expensive flesh of mammalia.

Yet both must be eaten together with other things which contain the necessary quantities of fat and carbo-hydrates, so that there may be taken in the ingredients essential for the due maintenance of the body.

In the above-mentioned treatise Sir Henry Thompson says:—

"On the southern coasts of England, notably in Cornwall and Devonshire, the fishing population, who work very hard, and require therefore an appropriate diet, deal with their fish in the following manner, and it forms the staple of their nourishment for a large part of the year:—Portions of any fresh fish are cut up and placed in a large pie-dish, among them some thick morsels of

fat pork, with salt and pepper ; the whole is covered with a substantial crust and baked. Mark how all the elements necessary to the man who toils hard are combined, and in perfect proportion to his needs. A moderate amount of nitrogenous matter appears in the fish, and also in the flour of the crust, which latter also contains the necessary starch. The fatty matters deficient in fish are furnished by the bacon, and also by the lard with which the crust is made, while the necessary salts appear in each of the constituents named."

Thus have the physiological requirements of the body imparted an instinctive knowledge of the best means of satisfying them to a people who are otherwise in a state of complete ignorance of the scientific principles underlying their selection.

In answer to these instinctive promptings—"cravings," as they are more popularly called—the dwellers about the south-east of Devon and Cornwall have hit upon a combination of food, characterised at once by its high physiological value and its savouriness as a dietary.

That the preparation of such a food on an adequate scale cannot, with a due regard to its full distribution and use, be left to the individual is a fact amply proved by experience. Prejudice, ignorance, improvidence, and idleness play so important a part in human existence that these factors ought always to be taken into account. To this must be added the difficulty in largely-populated places of obtaining, at a reasonable price, the necessary ingredients.

When we see how, in thinly-populated places, nature offers its riches in vain to those who need only devote some trifling labour to gather and utilise them, it becomes self-evident that industrial enterprise must step to the front, and, taking nature's offerings, turn them to account for the general well-being.

And what greater field could to this end be found than in procuring cheap and nutritious food for humanity, constantly increasing in such immense proportions? Eminent philosophers and economists have plainly enough indicated the danger existing in the disproportion between the increasing population and earth's producing power, a danger only to be avoided by the discovery of fresh sources of supply, or the better utilisation of old ones. And where, again, is there to be found a field for research wider and richer in its promise of reward to patient industry than the sea—the great fathomless deep—with its inexhaustible treasures waiting only to be gathered?

How poor is the producing power of the earth compared with the reproductive capacity of organic life in the water. Fish with their incalculable millions of ova require far simpler conditions for their development than vegetable life. But it is not enough that treasures exist; they must also be rightly used in order that they may subserve the individual and common interest.

It is this important problem which we have for some years been trying to carry out in a practical and satisfactory manner; and I will now mention some of the products which we have obtained, and which will soon be supplied as marketable commodities.

We begin with the Normal Co.'s extract of fish, shell-fish, and cetaceans.

The extensive consumption now-a-days of extracts of meat, such as Liebig's and others, has induced the Normal Co., Limited, to use materials other than meat for the production of extracts. The Normal Co. manufactures four different kinds of extracts.

No. 1—Meat Extract.

" 2—a. Fish "

" 3—b. " "

" 4—Shellfish "

No. 1 is exclusively made from flesh of whales and allied animals. Certain things, through the force of habit, are regarded with, to say the least, suspicion, and it takes time to overcome prejudices. What views may prevail, if indeed any have been formed on the subject, regarding whale flesh as a dietetic, it is impossible to say; but the mere suggestion might not improbably give rise to a vision of some unsightly mass floating in oil and nearly alike in appearance, taste, and smell. The flesh of the fresh whale in reality resembles that of the reindeer, although somewhat coarser and more streaky, with lard-like narrow layers of fat. It looks exceedingly palatable, and is entirely *free from smell or any flavour of train oil*. Extract made from whale flesh differs in no way from Liebig's or other kinds. It is as fresh and savoury to the palate, and does not leave the least unpleasant after-taste. The immense supply of the raw material makes it possible to select and pick out the best, which is not generally the case with other flesh, which is taken "rump and stump." An extract made from flesh chosen in such a way is of course both tastier and more wholesome, and as it can be sold for half the price of other articles of similar character, the advantages would soon be appreciated.

During the last ten years the Norwegians have prosecuted the whale and seal fishery. Captain Foyn opened up these two new branches of industry in Norway, and by energy and skill has achieved a success hitherto unknown, each whale realising about £300. This result was arrived at by only the mere sale of the train oil, the enormous quantity of valuable flesh, bones, blood, skin or fins, and other very valuable parts, hitherto considered comparatively useless, for want of sufficient chemical and technical knowledge, having been treated as so much waste matter. These, however, will by the Normal Co's. method be made to yield more than four times the profit hitherto derived from whale fishery. The average blue whale is from 50 ft. to 80 ft. in length, and from 30 ft. to 40 ft. in its greatest circumference, and weighs from 200 to 300 tons. A single whale sometimes yields 20 tons of train oil, which is obtained from the thick layer of fat or blubber, lying sometimes several feet in thickness under the skin. The average weight of the blue whale, generally found on the north coasts of Norway, is 200 tons, and contains, after the lard and inner fat has been taken away, 56,000 lbs. bones, 28,000 lbs. blood, 128,000 lbs. flesh, and 42,000 lbs. entrails, from which can be obtained as follows :—

From the Bones,	5 per cent.	Train Oil.
Do.,	20	do. Bone Glue.
Do.,	50	do. Bone Meal.
From the Flesh, assuming that only 50 per cent. can be released for Extract,		
Do.,	4	do. Extract.
Do.,	20	do. Guano.
Do.,	2	do. Train Oil.
From the Entrails,	15	do. Raw Gluc.

At present, as we have said, all these valuable products are thrown away, or left to poison the air for want of the aid of technical persons, who could exercise their skill in extracting from them the products enumerated above. It may, besides, be of interest to know that the valuable skin of the whale is at present only used for guano, although it has been proved to be far better suited for a great variety of purposes than any other skin—as, for instance, traces for horses, driving-reins, &c. Moreover, from the skin of the whale perfectly homogeneous pieces, measuring 70 feet in length by 4 to 8 feet in width, can be obtained.

What an enormous source of food this industry affords will be easily understood when one considers that the meat of a large blue

whale of 200 tons yields, in round numbers, 5,000 lbs. of extract. Every lb. of extract gives about 100 pints of soup ; so that the above-mentioned quantity of meat represents no less than 500,000 pints of soup. For comparison, I may mention that at the great slaughter-markets in Fray Bentos, where extract is prepared after Liebig's system, only about 10 lbs. are obtained from each ox. If we can, on the smallest computation, assume that the yearly catch of blue and sperm whales, &c., throughout the earth, amounts to 1,000, each weighing 200 tons, and the catch of smaller kinds at 20,000, weighing 3 tons each, we would find, after calculating, that from this quantity of flesh 10,000,000 lbs. of extract can be made, or equal to one thousand million pints of soup. *It would require one million oxen to obtain the same amount of extract and soup.* Considering that nearly all of those kinds of flesh hitherto have been thrown away, one may form some idea of the enormous loss and actual waste—a loss which may be said to be national. In order to show that these calculations are within the truth, I will only remark that in Norway alone no less than 400 large whales are yearly caught, while about 1,000 small ones are caught on the Faroe Islands alone.

Let me now refer to other kinds of Extracts made solely from fish.

If one examines the flesh of fish and mammalia, a very great similarity will be found between them ; the greatest difference exists in the condition of the fat and the percentage of it. As extracts consist wholly of extracted substances and salts, which are very similar in almost all kinds of fish, it will be easily understood that all such extracts ought to possess the same taste and be of the same composition. Soup made of Extract No. 2 is entirely free from any taste of fish, and cannot be distinguished from ordinary meat-soup in which some greens have been boiled. By a somewhat different way of treatment No. 3 Extract is made to retain a decided taste of fish, and is therefore used for making fish-soup, which is a well-known and much appreciated dish in many countries—notably in Russia. In that country, during the thirty weeks of fasting, immense quantities of fish-soups are consumed, and, during that time, this dish is to be found daily on the table of the rich and the poor alike.

The immense importance and significance of a new, cheap, and wholesome article of food must be apparent to everybody ; but we may specially mention its adaptability for armies, navies, hospitals,

workhouses, and all public institutions. It ought to prove an especial boon to that portion of the British army which is stationed in India, whose provisioning is often both difficult and costly, as the preserved foods used in other places cannot always be used there on account of the hot climate.

Finally, there comes the extract of shell-fish.

This extract is obtained from lobsters, crabs, mussels, &c. There are probably few marine animals which command, as articles of food, a larger number of admirers than the two first-named kinds. Without their presence in one form or another at the table, a dinner, however well ordered in other respects, is necessarily incomplete. They may well be considered as the truffle of the sea—rounding-off and imparting a delicate finish to the grosser and more ordinary components of the meal, which by themselves would quickly clog the palate and stomach of the epicure.

A serious drawback, however, in the indulgence in this luxury by the great mass of people has hitherto been its costliness. This it has been sought to overcome by tinned preparations, which are imported in immense quantities, and sold at a much lower price than the fresh fish, but still at a figure that places them beyond the means of a large number of persons who would gladly become consumers if they could do so at a more reasonable cost.

Although lobsters at the places where they are caught often have a very small value, yet many causes prevent any considerable reduction in their price, the principal one being the reckless waste of the raw material. For the purpose of preservation the lobster is boiled, the flesh is taken out, and in the usual way put into tins, from which the air is removed by boiling.

As it would involve too much trouble to remove from the shell everything that is eatable, those engaged in the business generally content themselves with utilising the flesh from the tail and the claws only, everything else being left to waste. This “offal” is, however, the best and most delicate part of the lobster, and from it an excellent extract can be easily made, which possesses the same fine taste and flavour as the flesh of the lobster itself. Such an extract may be used in soups, sauces, &c., a few drops of it giving, for instance, to fish a flavour exactly similar to that of real lobster. This extract must not be confounded with what is called “lobster sauce,” and which is now sold in the market as such, and might with equal propriety be called “oyster sauce,” or anything

else, as there is very little in it of that fine characteristic taste of the lobster.

According to Sir Spencer Walpole's "Official Report on the International Fisheries Exhibition," page 59, about 16,800,000 lbs. of canned lobster are annually manufactured in Canada alone. Taken at a low estimate, the value of the "offal" which, on the present system of manufacture, is treated as useless, amounts to two-thirds of the total weight of the fish in its live state. From this we deduce an aggregate of 33,600,000 lbs. as the weight of the fish annually treated at the Canadian Lobster Fisheries.

From the offal of the above aggregate may be easily obtained 8 per cent. of extract, or 2,688,000 lbs., and, reckoning its value at 5s. per lb., which is considerably lower than the current price for common meat extracts, this would yield an annual income of £672,000, in addition to the £556,000 derived from the sale of canned lobster. Moreover, the crab, which in many places has little or no value, can, with almost the same advantage, be used as a material for the manufacture of extract. Even the common mussel yields an extract which possesses in a surprising degree the fine flavour of the oyster, and which, used in soups or sauces, produces a nice and tasty food. As these extracts can be manufactured and sold at very low prices, people of small means are enabled to procure for themselves a wholesome and welcome change in their otherwise monotonous diet.

Another new product which is to be introduced into the market is Fish Sausages.

The more forms you are able to give to a product the larger is the market open for it. The fish-sausage may be varied *ad infinitum*, and can be made to suit the most fastidious tastes. In serving the fish whole only 60 per cent. of it is used, the remaining 40 per cent., consisting of head, bones, entrails, are thrown away.

When serving, therefore, the fish in form of sausage a great saving is effected, and a palatable food is obtained which can be kept fresh for a long time; some, indeed, which were only slightly salted and smoked, have been kept in a room for more than two months and still preserved their freshness and sweetness. Slightly smoked salmon and halibut in sausages are a perfect luxury. Both from mackerel and herring, either raw or smoked, a very good preparation can be made which, boiled or fried, would prove a delicacy on any table.

Lean fish, such as cod, may with advantage be mixed with minced pork fat, or cod's liver, from which part of the oil has been previously extracted. Real *bonne-bouches* can be prepared in many combinations, patties of lobster, cod's liver, with mushrooms, truffles, etc. Smoked herring sausages can be prepared in such a way as not to be distinguished from meat sausages.

In order to get a better view of the many products that are obtainable from the sea, I here beg to mention the following :—

WHALES AND CETACEANS.

From the flesh is obtained—oil, extract of food, glue, meat fibrine (excellent as food for dogs, etc.), guano.

From the bones—oil, gelatine, bone-meal.

From the entrails—glue, guano.

From the blood—albumen (it has been practically proved that at least two-thirds of the blood can be utilised for this purpose).

The sinews and the tanned skin of the whale can be used for traces, &c.

COD, LING, AND OTHER KINDS OF FISH COMPRISED IN WHAT IS CALLED "GREAT FISHING" OR "SEA FISHING."

The flesh is used for dried fish, or for extract, glue, guano.

The bladder for isinglass.

The backbone for glue, bone-meal.

The head, when fresh, for extract, glue, guano ; when dried, for glue and guano.

The roe for albumen.

The liver for oil, extract, fibrine (excellent as food for dogs).

The entrails for glue and guano.

The external coverings of the larger kinds can be profitably removed and tanned. They give a strong and good skin, very suitable for portfolios, bookbinding, etc.

Most of those kinds of fish which are considered unsuitable for food, such as the dog-fish, ray-fish, &c., can, with a few exceptions, be used with great advantage for extract preparation, etc., and it is chiefly these raw materials, now considered as almost valueless, which the Company intend to utilise and have utilised.

Herring and sprats, which are not to be salted, can be used for extracts, oil, glue, and guano, or for fish sausages.

Crabs and other shell-fish, mussels, etc., can be used for extract, or sauces, or cheaper guano.

Thus we learn that every part of the fish can be utilised and the opprobrious word "refuse" may, so far as the produce of the sea is concerned, be struck out of modern vocabulary.

In the United Kingdom, with its enormous coast-lines, the development of the fisheries is of an overwhelmingly great importance. The great poverty which exists specially among the Irish and partly also among the Scotch fishermen, has for years past shown the necessity of making energetical arrangements as well by the Government as by private persons. Many proposals for their improvement have been made, but they have all met with the same difficulty, namely—in far-away places, out of the usual lines of communication—of getting a market for the fishermen's products. It is quite natural that a product like fish requiring a great deal of room, and being perishable, is more risky and more expensive to transport from one place to another than any other goods. As before mentioned, the Normal Company is able to manufacture fish products of various kinds, as well for food as for other purposes, for which fish offal as well as fish itself can be used. Under such circumstances it will be easily understood that fish utilised in this way, both by its durability and higher sale price, will stand a much longer transport as well as a higher rate of freight than the fish itself. In this way factories for utilisation of fish, erected on places at long distance from the larger steamship routes, should give great advantage both for private enterprise and for the fisherman; and if then a company or the Government, with a capital at their disposal, would supply the poor fisher people with means for the purchase of tackle, boats, &c., I believe one part of the great Crofter question would be solved in a natural and practical way.

That fish (in the exact meaning of the word) has not become a popular food, is a sad fact which, to a large extent, is a consequence of the one-sided way of its treatment. Where is a richer working field to be found for the obtaining of food-products than in the sea? To make use of those riches for the preparation of food and other products is the aim of the Normal Company, whose chairman is Mr. Nordenfelt, the celebrated gunmaker of London, who intends to start factories in various places for carrying out our patented inventions. We also intend to establish in more populous places soup kitchens, where a substantial meal of two dishes may be had for about twopence. (A kitchen of that kind is likely to be shortly opened in London). The principal ingredients in these

dishes will be fish, but they will besides contain fat, vegetables, meat, &c., mixed together in proportions which will make a thoroughly physiological food. Many a one may remark that the class of people that principally would visit such a dining place would not care much for the fish. That may be when the fish is boiled or fried, but surely not with respect to the kinds of food we intend to supply. I dare say even the most fastidious taste is unable in several of our soups to perceive the least sign that the principal ingredient in these soups is fish. It is the same with our fish sausages, fish pudding, &c., which rather remind one of the common meat dishes. I may state at once that the object of these kitchens is not to give alms to the poor. I fully agree that direct pecuniary assistance is sometimes permissible, and even requisite to alleviate an occasional distress; but it is a fact that this way is quite as hard and demoralising for the receiver as it might be a burden to the giver. There is so much distress, so much poverty in the world, that even the deepest pocket would not suffice to redress the same.

No, give the poor work, and let the aim of mankind be to provide them with the first condition of existence—food—at the cheapest possible rate. But to realise this laudable object, the means to make it permanent must be constructed upon a purely mercantile basis, in order that both producer and consumer may benefit alike.

XX.—*The Epidemic History of Glasgow during the Century 1783-1883.* By JOHN GLAISTER, M.D., Lecturer on Public Health, Glasgow Royal Infirmary School of Medicine, &c.

[Read before the Society, 14th April, 1886.]

THE Epidemic history of Glasgow during the last Century—1783 to 1883—is one of extreme interest, not only to the ordinary citizen, in respect that anything of the history of our city is to him of interest, but also to the physician and the sanitarian, in respect that it brings before his mind not only disease as an entity in its fearful ravages, but also the sanitary surroundings of the inhabitants during, and before and after, the several visitations.

The visitation of an epidemic in the earlier part of the period of which I treat was formerly looked upon as a punishment for deeds committed, from the hand of God; it was only given to a few in advance of the general line of ideas to believe and to say that there existed a causal relationship between the sanitary surroundings and the visitation and spread of the disease.

The prevalence of this general idea acted as a barrier to the advance of more enlightened views, because, filled with the view that there was something mysterious and supernatural about disease and death when it presented itself in that terrible way, people could the less readily conceive that the cause, if not of the origin, at least of the facility for the rapid growth of the disease, lay in the conditions among which they were surrounded, and to which they had in ordinary sense habituated themselves.

In order to appreciate most fully the extent and character of the different visitations, it will be necessary for me to review briefly several of the conditions which tend to impede or provoke the presence of epidemic disease, as illustrated by those obtaining in our own city—these conditions, indeed, which contribute to influence the health of the people, and express themselves in a tangible way in the death-rate.

These conditions are—

- 1st. The extent of the city at the beginning of 1783, and the density of its population.
- 2nd. The immediate hygienic surroundings of the inhabitants.
- 3rd. The water-supply.

- 4th. The sewage-disposal arrangements; and
- 5th. The attempts which have been made to improve the sanitary condition of the city during this period of one hundred years.

First—GLASGOW IN 1783.

The principal parts of Glasgow consisted of the city proper, of the villages of Gorbals, Bridgeton or Barrowfield, Anderston, and Finnieston. The New Town, as it was called for a long time—that part bounded on the west by Queen Street or the Cow Lone, on the east by North Albion Street, on the south by Ingram Street, and on the north by George Street—did not exist at this time, but the building of it was commenced in 1786, three years later. As yet Tradeston, Port-Dundas, Hutchesontown, the neighbourhood of Bath Street, and the district of Blythswood, and Laurieston, did not exist as populous localities. Partick was an adjacent village.

The principal streets of the City were the following:—Argyle Street, Bell Street, Blackfriars' Wynd, Bridgegate, part of Buchanan Street, Campbell Street, Candleriggs, Canon Street, Castle Street, Charlotte Street, Clyde Street west, Drygate, Dunlop Street, Gallowgate, Havannah, High Street, Ingram Street, Jamaica Street, King Street, Kirk Street, Limmerfield Street, Miller Street, New Wynd, Old Wynd, Princes Street, Queen Street, Rottenrow, Saltmarket, St. Andrew Street, St. Enoch Square, Stockwell Street, Trongate, Virginia Street, Weaver Street, Wilson Street.

The population of the city and the suburbs was about 44,000, and the inhabitants were closely housed together.

The year 1782 is memorable because of the overflowing of the Clyde. During this flood the Bridgegate and the surrounding low-lying parts were under water, and the village of Gorbals “was so completely surrounded that it seemed like an island rising up in the midst of an estuary.” The river at this time rose 20 feet above its ordinary level. (M’George, *History of Glasgow*, p. 255.) Again in 1785 and in 1808 were the lower parts of the town submerged by risings of the river.

In 1785 there happened two meteorological facts worth noting:—first, there was the longest continuation of frost ever remembered, for, after remaining 176 days, the ice on the Clyde broke up on the 14th of March; and second, on the 25th June, the thermometer

in the shade stood at 85° Fah., which is very near the medium heat of Jamaica.

The principal trade of the city at this time, viz., the tobacco trade, was suspended owing to the War with America, which only terminated in this year.

Up till 1780 there were no public lights put out at night for the guidance of wayfarers; not even in the Trongate was there any other way of piloting the way except by the hand-lantern or "bouet" which each carried. In that year, however, the magistrates agreed to put up nine lamps on the south side of the Trongate, between the Tron Kirk Steeple and Stockwell Street. By the Police Act of 1800 (39 and 40 Geo. III. Cap. 88), it was permitted to affix oil lamps to houses, but it was not till the 5th September, 1818, that gas was introduced as a lighting medium.

In this connection it is interesting to note an announcement made in the *Courier* of 16th January, 1849, that "J. H. Pepper, Esq., of London, Member of the Chemical Society, etc., will deliver a lecture in the City Hall on Voltaic Electricity, with reference to its applicability for illuminating purposes, with an exhibition of the Electric Light;" and it is of special interest to this Society to note that, on Wednesday, the 17th January of the same year, the electric light was exhibited at a meeting of the Philosophical Society held in Anderson's College, by Messrs. Glassford and Finlay.

In 1783 the watching of the city was in the hands of the City Guard, a body composed usually of about 40 members, who met each evening at the rendezvous, and there and then appointed the captain for the night. It was compulsory, that each male citizen who paid a rental of £3 and upwards yearly should take service in turn, or pay half-a-crown for a substitute. In 1788 the Guard was assisted by a small police force organised by the magistrates; and by the Police Act of 1800, watchmen were to be appointed "for guarding, patrolling, and watching the streets."

The most usual means of local conveyance was the sedan-chair; hackney carriages were practically unknown. Short journeys from the city to neighbouring towns had to be made on foot, or on horseback, for coaches had not yet been established except to Edinburgh. Indeed, it was not till 1788, that the first coach from London, arrived in the city, having taken 63 hours on the road.

Those inhabitants who could not afford the luxury of a sedan-

chair, had to wear "pattens," to protect their boots from the very dirty streets.

Large manufactories were few, consequently the atmosphere was almost untainted.

Second—HYGIENIC SURROUNDINGS.

The greatest sin against hygiene then prevalent was that which prevailed up till a much later date, viz :—the presence of dunghills and privies close to dwelling-houses. Even at a much later date it was stated that the contents of the dunghill were allowed to accumulate until they realised sufficient in money return to pay the rent.

In the streets, too, the refuse was supposed to be carried away by surface-drains or "syvers;" these, however, became stagnant and their contents putrid and decomposing.

Overcrowding in the lower parts of the town was very common ; indeed, to this factor was attributed the great mortality and facility of convection of epidemic disease. This practice was not confined to the poorer classes, because it was the habit even of the better classes to live in flats, and to this is attributed the fact that the occupants frequented the club or the tavern so much. It was the usual habit, too, for the physician and the lawyer to consult at his club, a practice which contrasts strongly with the present custom. Curiously enough, no provision was made against this in the first Police Act of 1800 ; but in the Act of 1841 a check was put to the overcrowding of lodging-houses in Calton, "one of the suburbs of Glasgow," and by a similar Bill for the city in August, 1843, the numbers accommodated in such houses were put under the control of the superintendent or other officer of the city police. (Watt's *Mortality Table, 1843-44*, p. 113.) What may be termed the sanitary parts of the Act of 1800 embraced the daily cleansing of the pavements by the householders, the removal of nuisances from the pavements, the erection of water-pipes to carry off water from the roofs of houses fronting public streets, the appointment of scavengers to cleanse the streets, and the prevention of dunghill contents lying on the streets after twelve o'clock noon. It is very evident that this was required, because in the front of the houses in Trongate in 1795 middensteads and haystacks were commonly seen.

Add to the insanitary surroundings of the home already depicted, imperfect ventilation and low ceilings, and you will arrive at a fair idea of the hygienic conditions in which most of the inhabitants lived.

In the Trongate, however, about 1783, many of the houses had gardens attached to them, for we read in the *Glasgow Courier* of 1789 that a certain garden, bounded by Trongate, Candleriggs, and Ingram Street, was for sale. Brunswick Street runs through the centre of it. The Deanside Brae—that part lying between Rottenrow and George Street—was vacant ground, and in the meadow was to be found the Meadow or Deanside Well.

The Rottenrow in 1780 must have been a comparatively open space, because in this year an advertisement appears in one of the papers offering “summer quarters at the west end of Rottenrow, in the common gardens.” (M’George, *loc. cit.*, p. 155.) From about Stockwell Street—the westmost part of the town—to Anderston, stretched a country road, bordered by hedges, with fields and gardens on each side.

Third—THE WATER SUPPLY.

In 1780 the city depended solely for its water supply on public and private wells. At the beginning of the present century the number of the public wells was twenty-nine. Before the former date, however, there exists evidence that the authorities felt the necessity for a better water supply, because the records of 1776 show that a payment of £8 8s. was ordered to be made to Dr. Irvine “for his trouble in searching round Glasgow for water to be brought into the town.” (M’George’s *History*, p. 294.) Again, in the end of the last century, did the necessity show itself. Several of the principal inhabitants, with the Magistrates, commissioned Mr. James Gordon, of Edinburgh, to supply them with plans, their intention being to secure a supply from Whitehill, but being found too limited, the scheme was abandoned. In 1794 another attempt was made towards the same end. A committee, consisting of Messrs. John Stirling of Cordale, James Hopkirk of Dalbeth, and Henry Glassford of Dugaldstone, was appointed to put the scheme in action. Mr. M’Quisten, civil engineer, was employed to guide the committee. This he did by giving a report of sources of supply, with estimates of cost. But again was the scheme abandoned, partly on account of its expensiveness, and partly from the instability of the proposed supply. Cleland remarks of it, “I am doubtful if the supply would have been equal to the demand even of the public works.” (Cleland, *Report for 1831*, p. 197).

It was not till 1804 that a new supply was introduced into the city, and that by a single individual. Mr. William Harley feued the lands of Willowbank from the Blythswood estate, and finding excellent springs in his land, conceived the idea of introducing the water into the city. This he did by erecting a reservoir in Upper Nile Street (now West Nile Street), which was fed from the springs by pipes. From the reservoir the water was distributed through the town by means of "square cisterns on four-wheeled carriages," and was sold at the rate of a halfpenny a stoup. This supply was excellent, though insufficient, but it had the effect of once more stirring up the citizens to consider whether a pure and abundant supply could not be obtained.

A scheme was floated, the cost to be defrayed by voluntary subscription. The subscription collected, in 1806 the subscribers obtained an Act of Parliament which incorporated them under the name and title of "The Glasgow Water Company." In it powers were given to certain subscribers named—many of them still well known Glasgow names—to put the Act into force. It was then decided to get a filtered supply from the Clyde, "about two miles above the town."

Two years afterwards, 1808, another company was formed called "The Cranstonhill Water Company," and its source of supply was "from the river *below* the Town."

About 1830, however, this source was changed to a position above the town, close to the works of the former Company. I am sorry that I cannot ascertain why this change was made, although there are very obvious reasons why. What seems astonishing is, that any company should have been permitted to draw water from a river after it has passed through a town, when it must have been seriously contaminated with sewage and other products. It must be borne in mind, however, it was not until 1814 that sewers began to be constructed; but even before this, the small streams running into the river—the Molendinar and St. Enoch's Burn—were practically the recipients of the sewage along their banks, and this obtained even from the inception of the Cranstonhill scheme.

The supply from these companies was conveyed to the town by means of iron pipes.

The money laid out on both schemes up till 1830 was about £320,000.

This supply served the town along with the wells until about

1846, when the Gorbals Gravitation Water Company was started, its gathering ground being near Mearns. In 1854 it was computed that the Glasgow Water Company supplied the north side of the city with 12,000,000 gallons, and the Gorbals Gravitation Company the south side, with 3,300,000 gallons. (Dr. Strang, *Report for 1861*, pp. 33, 34.)

Ultimately, however, it was thought expedient that the Corporation of the city should take the water-supply into its own hand. The Loch Katrine scheme was then instituted. The works were commenced in 1856, and completed on 14th October, 1859.

Then the old Glasgow Water Company ceased, the Gorbals Company's supply being still allowed to remain.

The amount of water daily brought into Glasgow has been estimated thus:—from Loch Katrine, 35 million gallons, from the Gorbals Supply, 5 million, giving a total of 40,412,000 gallons for 167,000 families.

In 1861 the supply per head per diem was 42·6 gallons; in 1862, 42·7 gallons; in 1863, 42·3 gallons; and in 1864, 47 gallons. (*West Watson's Report*, p. 58).

In 1884 about 42 million gallons were daily supplied to 765,000 persons, or a little over 54½ gallons per head per diem, if we omit calculating the public works' supply.

It was found necessary, in order that the water-supply should keep abundant for a rapidly-increasing population, and for the increasing consumpt by public works, to approach Parliament in 1885 to obtain further powers (practically to duplicate the present supply). It has been estimated that the enlarged works "will enable a supply of 75 million gallons per day to be maintained to the city in all time coming, and the quantity of water will supply a population of 1½ millions with fifty gallons per head each day." (*Nicol's Statistics, 1881-1885*, p. 112).

The following is the analysis of Loch Katrine Water made in 1854 by the late Dr. Thomas Anderson, Professor of Chemistry in the University:—"It is a clear and colourless water, and of unusual purity, the total quantity of solid matters contained in a gallon amounting to only 2·20 grains, of which 1·35 is mineral and .85 organic matter. The mineral matter is composed chiefly of salts of soda and lime. It contains in solution, 7·25 cubic inches of air per gallon, 4·75 of which were nitrogen, and 2·50 oxygen, along with a trace of carbonic acid. Its hardness is 0·9." In this latter particular he differs from Dr. Taylor, F.R.S., of Guy's

Hospital, who states that the hardness was $1\frac{1}{4}$ ° Clark's scale. In 1865 an enquiry was instituted by the authorities regarding the propriety of closing the public wells, and Professor Anderson was asked to analyse and report on their waters.

The following is a table showing the results:—

ANALYSIS OF PUBLIC WELLS IN 1865.
PROFESSOR ANDERSON, GLASGOW UNIVERSITY.

WELLS.	Total Solids.	Fixed Salts.	Volatile Matter.	Oxygen required for Oxidation of Organic Matter.	Nitric Acid.
1. Arn's Well,	29·75	21·75	8·01	0·035	Considerable
2. Large Spout, first east of Humane Society's House,	20·96	15·48	4·48	0·035	Small
3. Small Spout, second east of Humane Society's House,	20·32	16·96	3·36	0·070	Small
4. Large Spout, opposite east end of Gymnasium, ...	18·88	15·36	3·52	0·035	Small
5. Large Spout, opposite west end of Gymnasium, ...	25·12	20·32	4·80	0·035	Small
6. Clelland's Well,	15·36	12·32	3·04	0·033	Moderate
7. Robin's Well,	13·84	8·72	5·12	0·035	Small
8. M'Gavin's Well (near Charlotte Street),	19·36	14·64	4·72	0·030	Small
9. Pump Well in John Street, Bridgeton,	77·52	61·52	16·00	0·070	Extremely large
10. Pump Well in Old Coach Office Court,	34·80	27·20	7·60	0·070	Extremely large
11. Spring Well near Kelvin-grove Street, off Sandyford Street,	11·36	9·04	2·32	0·052	None
12. Spring Well in Kelvingrove Park,	24·64	18·88	5·76	0·050	Rather large
13. Loch Katrine,	2·20	1·24	0·96	0·070	None

REMARKS.—It was recommended that Nos. 1, 6, 9, 10, 12 should be closed entirely, or should not be used for drinking purposes. No. 9 contains as much as 32·2 grains of sulphate of lime per gallon. No. 11 is very good, and might be used with perfect safety. Rest ought to be closed, if Loch Katrine can supply their absence. The chief contamination is due to sewage products having percolated into the wells from the neighbouring soils.

The public wells in 1783 were situated as follows :—

- Barras-yett Well (open draw well), foot of Saltmarket.
 - Westport Well, opposite the old Black Bull in Trongate.
 - Ministers' or Priests' Well, on the banks of the Molendinar.
 - The Lady Well, on the banks of the Molendinar, but a little further down.
 - Arn's Well (arns or alders), on the Green.
 - Bridgegate Well, in the Bridgegate.
 - Of the private wells, one of the finest was in the grounds of Mr. Black's (of Claremont) mansion in Jamaica Street.
- (M'George, p. 294.)

Cleland gives a table of the differences in weight of the waters from four different sources. The test being the Scotch standard pint filled by the waters at the same temperature :—(*Report, 1831*, p. 197.)

SOURCE.	WEIGHT.			
	Lbs.	Oz.	Drs.	Grs.
Arn's Well,	3	11	14	8
Water Companies' Pipes,	3	11	15	0
West Port Well,	3	11	15	11
Bridgegate Well,	3	12	0	12

Fourth—THE SEWAGE-DISPOSAL.

In 1783 there were no common sewers. The surface-water run in gutters or "syvers" along the side of the streets, and were contaminated by filth in abundance. In 1790, however, the first sewer was constructed by the New Town Building Company, "in George Square and Buchanan Street, and terminated in St. Enoch Square and Buchanan Street, and terminated in St. Enoch's Burn, where it crossed Argyle Street." Then Mr. Stirling of Cordale constructed one to drain his town house, now the site of the east compartment of the Royal Exchange. Then, between 1809 and 1812, Stockwell and Jamaica and a few smaller streets were provided with them by the Corporation. But it was not until 1814 that the authorities awoke to the necessity for a more enlarged scheme of sewers, for between that year and 1819—five years—four miles of sewers were laid. (Cleland, *op. cit.*, p. 255.)

From that time till 1861 the scheme became more and more complete, until in that latter year "the total length of main sewers within the municipal boundary was 60 miles, and nearly all the streets were provided with them." Camlachie, Westmuir, Parkhead, Springburn, Woodside, however, had none, the open water-

courses being the only means of drainage. Bridgeton and Mile-end had a limited sewer supply. (Strang's *Report for 1861*, pp. 33-34.)

There still exist, nevertheless, streets in the older portion of the town which are unprovided with sewers.

The unfortunate fact connected with the ultimate disposal of the sewage is that it has all been diverted into the Clyde, which is now not inaptly termed "an elongated cesspool;" and the presence of which sewage is not difficult to discover by the olfactory organ of any passenger on the river in the summer season. This is the *questio vexata* of the authorities, and meanwhile awaits a satisfactory solution.

Mr. Bromhead, in a paper read before the Philosophical Society on this subject, has estimated the daily quantity of sewage poured into the river. He says "the sewage pouring into the harbour is composed of half a gallon of excrement to 45 gallons of water, and sundry other items, from 710,000 people. There are 168½ gallons to a cubic yard. From these figures it appears that there are 200,000 cubic yards of sewage poured into the harbour every day." And he adds, with which I entirely agree, that "the limited quantity of pure water that we at present add to the excrement produces sewage which is grossly offensive."

It remains for me now to discuss the last point to which I directed your attention :—

Fifth—SANITARY IMPROVEMENTS.

Some of these I have already indicated in the foregoing, but, while contenting myself with only mentioning the introduction of the water-closet system, I would specially wish to mention two factors which seem to me to have improved the sanitary condition more than any other. These are, the introduction of railways into and through the city, and the operation of the City Improvement Trust.

The Union Railway, for instance, by penetrating some of the worst parts of the city, has opened air-paths which were much needed.

This factor, however, is of less importance than the City Improvement Trust, a short sketch of the operations of which will prove of interest.

The Act (29 Victoria, cap. 85) was passed by Parliament on 11th June, 1866, the preamble of which is as follows:—"Whereas

various portions of the city of Glasgow are so built, and the buildings thereon are so densely inhabited, as to be highly injurious to the moral and physical welfare of the inhabitants, and many of the thoroughfares are narrow, circuitous, and inconvenient, and it would be of public and local advantage if various houses and buildings were taken down, and these portions of the said city reconstructed, and new streets were constructed in and through various parts of said city, etc., etc., etc." (Amendments and extensions in 1871 and 1880.)

The scheme was originated to pull down properties in certain localities which had attained a notoriety by reason of their insanitary state, and from their being the resort of that floating population which contributes most to the commission of crime, etc.; to erect in their place buildings sanitarily constructed, and to widen the streets demolished; to open lodging-houses on the model principle for the convenience of the vagrant and floating population; and, lastly, for the purpose of securing recreation grounds for the use of the citizens, in the form of public parks and open spaces.

The scheme embraced an area of 88 acres, with a population of 51,294 persons, and the average rate of mortality within this area amounted to 38·64 per 1000—ranging from 17·98 to 48·81 per 1000—the death from epidemic diseases forming 36 per cent. of this mortality. The average density of population was 583 per acre, but in some parts it amounted to 1000 per acre, the average density of the rest of the city being 83 per acre.

Section 28 of the Act defines the extent of displacement of population to be allowed at any one time. Within six months, no number of persons exceeding 500 can be displaced without certification granted by the Sheriff of the County, on evidence given that accommodation already exists or will be provided for those displaced.

The demolition of houses commenced about 1870, and from that time till May, 1874, the homes of 15,425 persons were destroyed. In May, 1874, 351 more houses were pulled down in some of the worst districts, viz.:—St. Andrew's Square, Calton, and Main Street, Gorbals. Of those removed it was ascertained that, before removal, 990 persons were housed in 403 apartments; of the 263 families, before removal, only 12 had water-closet accommodation, since removal, 35 had the benefit; the remainder—241—had to use common privies and ashpits,

which were situated so close to the dwellings that they were a nuisance in the highest sense.

Of the whole families removed, nearly 50 per cent. occupied houses of one apartment.

At May term, 1875, 818 families were displaced by their houses being torn down; of these, 84 per cent. were ticketed houses, i.e., lodging-houses under Public Health Act, or houses of not more than 3 apartments, and under 2,000 cubic feet air capacity, under Glasgow Police Act. The district operated on was Gorbals and High Street. Before removal, 55 per cent. lived in houses of one apartment, and 2,720 persons lived in 1,034 apartments. Before demolition, only 7 per cent. had water-closet accommodation; the remainder, common privies and ash pits.

In May, 1877, the number of houses demolished was 560, occupied by 2,100 persons, of whom 12 per cent. were lodgers. The scene of operations was the Central, Southern, and Eastern Districts.

In short, the homes of about 21,235 persons were demolished during these different operations.

	Persons.
Before May, 1874,	15,425
May, 1874, and May, 1875,	3,710
May, 1877,	2,100
Total,	<hr/> 21,235

(*Brit. Med. Jour.*, vol. ii., 1878, p. 207, Dr. Russell).

This large population, in large part, before removal, lived within half a mile of the cross, but after removal, it was found that the large bulk migrated outside that area.

As was to be expected, the gross rental paid by those compulsorily removed was greater after removal than before, but they got better value for their increased outlay in the form of better houses to live in, and better sanitary conditions to live amongst.

Of the ground left by the demolitions, part was occupied by railways, and part was rebuilt upon by warehouses and other such structures, with house accommodation on the upper storeys to suit a better class of tenants; the remainder is still unbuilt.

The Trust did not erect houses of the class demolished, because, whether stimulated by the action of the Improvement Scheme or not, house-building became at this time a mania in Glasgow,

and private enterprise ran up whole streets of houses in opener parts of the town.

It has been with truth remarked, that had Glasgow, along with its Improvement Act, also obtained a building Act, the sanitary benefits resulting would have been much greater; because the system obtaining in Glasgow of building blocks of houses in the hollow-square form is, on all hands, acknowledged to be far from the best. And to show how far the building mania extended at this time, it is only sufficient to state, from 1866 to 1876 one-fourth of the total inhabited houses at the latter date were built within that decade, and of that quarter, 93 per cent. were houses of one, two, or three apartments.

I may sum up, *apropos* this one feature of the Improvement Scheme, in the words of Dr. Russell, who has so worthily presided over the Health Department of the City during these operations, as follows:—

“The operations of the Improvement Trust must in themselves be productive of good, inasmuch as they expel from circumstances, than which none worse could be found or imagined, a body of morally debased and physically deteriorated inhabitants, and make straight and spacious thoroughfares in place of cramped and inconvenient wynds and closes. But we must see to it that we are not building up with the one hand houses which may, for want of sufficient restrictive and regulative power, become as bad in process of time as those which we are pulling down with the other. We must also continue to look to the habits in the new localities of the people who have been expelled from the old, and by a constant pressure compel them to distribute themselves, and endeavour to divert their intemperance and improvidence towards house-rent in a larger proportion of their earnings.” (*Trans. Philosoph. Society*, vol. ix.—1873-75, pp. 207, *et seq.*)

Besides this very important part of the scheme, the citizens have obtained the Alexandra Park and other open spaces. There have been erected in nearly every district of the city, Model Lodging-houses, which, ever since 1879-80, when the first return from them was made, up till the present time, have yielded a return of from £2 4s. to £5 7s. 7d. per cent.

Since the opening of the scheme, the cost of the properties acquired by the Trust to carry out the terms of the Act, amounts to £1,924,938 1s. 1d. sterling; and up till 1875 it has cost the

ratepayers £522,996 19s. sterling. The benefits which they have obtained are as follows:—

“(1) The Alexandra Park.

“(2) 92,722 square yards of ground applied in the formation of 27 new streets, and in the improvements of 24 existing streets, being 28,052 square yards of street surface beyond what was contemplated in the original scheme; and,

“(3) The Sanitary and Social Amenities produced by the street survey, and other public works, which cost £101,970 2s. 2d. (*Abstract Statement of City Improvement Scheme, 1884-1885*, Appendix No. 3.)

For those who may wish to pursue the subject in greater detail, I give the following bibliography of the subject:—

Philosop. Soc. Trans., vol. ix., 1873-75, pp. 207, *et seq.*

Glasg. Med. Journal, vol. viii., 1876, pp. 235, *et seq.*

Brit. Med. Journal, vol. ii., 1876, pp. 206, *et seq.*

Papers by Dr. Russell.

Report issued to Town Council by Dr. Russell and Mr. K. Macleod, Sanitary Inspector, 1877.

Abstract Statement of City Improvement Trust, May, 1884, to May, 1885.

It will now be interesting to inquire into the epidemic history of Glasgow during this period of one hundred years, *viz.*, from 1783 to 1883.

The extreme prevalence of smallpox in the thirty years from 1783 till 1812 is noteworthy; and the diminution of the disease on the institution of vaccination is well observed in the last of the three decades.

The first point to be noted, then, is the *great mortality among children under ten years of age from smallpox at the end of last century, and also the large percentage of deaths under the same age to the total number of deaths.* This last point is well shown in the following table:—

Year.	Total Deaths.	Deaths under Ten.	Smallpox.
1783,	1,413	719 or 50·8 per cent.	155
1793,	2,045	1,126 or 54·6 ..	389
1803,	1,860	940 or 50·5 ..	194

The former observation is also shown by the following figures. (Watt, in condemning inoculation, says it increased the smallpox death-rate, and this it did without doubt.)

I. From 1783-1792—Total deaths under ten, . . .	9,919
.. .. Deaths from smallpox, . . .	3,468
	Nearly 35 per cent.
II. From 1793-1802—Total deaths under ten, . . .	9,080
.. .. Deaths from smallpox, . . .	2,894
	Nearly 32 per cent.
III. From 1803-1812—Total deaths under ten, . . .	10,913
.. .. Deaths from smallpox, . . .	1,013
	Nearly 9½ per cent.

(Dr. Robert Cowan's MS. Papers in Glasgow Medical Society.)

From 1783 up till 1830 the total deaths include still-births, because the number of deaths was calculated from the burials.

The particular years in this period in which the disease was most prevalent were 1784, 1787, 1788, and 1791; and the years in which it was least prevalent were in the last decade, viz., 1806 and 1810, when there were only 28 deaths under ten years of age in each year.

In the first decade, 1783-1792, the mortality under ten years of age was 56·33 per cent.; in the second, 1793-1802, 54·42 per cent.; and in the third, 1803-1812, 50·06 per cent. It is well to bear in mind that Jenner's immortal discovery was made in 1796.

In the year 1808 a very fatal epidemic of measles fell on the city, the number of fatal cases being 787—all under ten years.

Typhus fever, which had always prevailed in Glasgow (had become endemic), assumed a very serious epidemic form in 1831, and continued during 1832. But there was also a very serious outbreak in 1818. This succeeded on the stagnation of trade of 1816 and 1817. In this epidemic there were admitted to the Fever Hospital, between 30th March, 1818, and 12th July, 1819, 1,929 patients, of whom 171 died. "During this period 5,000

apartments in city and suburbs were fumigated: 600 lodging-houses were examined, infected bedding was burned, and the owners supplied with new bedding." (Cleland, p. 255.) The large sum of £6,626 14s. 1d. was raised voluntarily for the relief of the sufferers.

The epidemic of 1831 spread very severely. On the 29th November of that year it was reported at a public meeting of the inhabitants, called by the Lord Provost, that it was advisable to consider the propriety of forming a Board of Health "to provide for the suppression of Typhus Fever, which had been spreading its ravages through the city and suburbs, and for which the accommodation of the Infirmary has become inadequate." The number of cases has not been exactly recorded for this year, but in 1832 Dr. Corkindale, Surgeon to the Corporation, reported that from 1st January to 3rd November, 3,368 cases had been under charitable treatment, either in hospital, or at home by the district surgeons.

Cleland says (p. 313):—"Although they cannot be enumerated, the number of fever cases and deaths, in families was very great."

Doubtless this may be somewhat accounted for by the presence in the city of a disease still more dreaded than fever, viz., Cholera. It would seem that in the consideration for the greater disease they somewhat lost sight of the lesser.

The cholera epidemic of 1832 was traceable from Hamburg to Sunderland. The vehicle of contagion was a ship which arrived at the latter port in October, 1831.

It then spread to Newcastle and Gateshead, by December it was at Haddington, then, in January, 1832, it had reached Tranent; two weeks later, Musselburgh, and in February it appeared in Edinburgh; it then travelled onwards to Maryhill, and eventually appeared in the Goosedubs of Glasgow, and in Partick on the 12th February. On that day Dr. Arthur, Deputy-Inspector General of Hospitals, and Drs. Laurie and Corkindale, reported one case in the Goosedubs, in the person of an old woman, named Janet Lindsay, and the other in Partick in the person of William M'Alpine, a quarryman, both of whom died.

The authorities of the city were not, however, unprepared for the epidemic.

I have already mentioned the meeting called by the Lord Provost, on the 29th November, 1831, in connection with the

epidemic of fever. This proposed Board of Health was "to guard against the visitation of the calamity (Cholera), to provide for the suppression of Typhus Fever, etc., and to promote the welfare of this great community by every means which could avert the approach or effect the extinction of the disease. (Cleland, p. 307.) The Meeting unanimously approved of the formation of a Board of Health, the Board to consist of the Lord Provost, Sheriff Robinson, Principal Macfarlane of the University, and a numerous body of clergy and laity, including a number of medical gentlemen. To aid the Board, a Medical Committee was appointed consisting of the following members:—

Dr. John Burns, F.R.S., University Professor of Surgery—Convener.

Henry Marshall, Esq., Deputy Inspector-General of Hospitals, and

Dr. James Corkindale, LL.B., Surgeon to the City Corporation—
Joint-Secretaries.

Ordinary Members of Committee—Drs. Richard Miller, John Balmanno,
Thomas Thomson, James A. Laurie, John Spittal, Robert Badenoch,
Alexander Panton, and John Gibson, Esq.

The committee fitted up five cholera hospitals, one lazaretto, and one large fever hospital, over and above the existing hospitals in Gorbals, Calton, and Anderston. The cholera hospitals together contained 282 beds, and were distributed throughout the town. The lazaretto, or receiving-house, was for the reception of those leaving infected houses.

Besides these arrangements, dépôts of medicines were fitted up in various parts of the town.

On the 7th January, 1832, the fever hospital was opened, and was immediately filled with patients; but, says Cleland, "Through the kind and merciful providence of God, there have not been at any time 40 cholera patients in all the hospitals put together."—Cleland's Report, Appendix, p. 307. The managers of the Royal Infirmary took charge of the fever hospital on its being handed over to them by the Board of Health. It is interesting to learn that ambulance work was so far attended to at this time in the transmission of fever-stricken patients from their homes to the hospital, for we read that "Convener M'Lellan made a present to the Board of a carriage with a spring bed, for conveying patients in a reclining posture from their houses to the hospitals, which has been found of great use; and Bailie Burn, one of the magistrates, made a present of a horse and harness."

Considering the wholesale destruction of infected bedding and clothing which every such epidemic entails, the citizens were

Philosophical Society of ...

ited to make gifts of cast-off clothing. This they did to the number of 8,190½ articles—the half being a single blanket; besides these, new articles of clothing and cloth for making were purchased by the committee to the extent of 576 articles, while they further relieved from pawn 1,299 articles.

The Cleansing and Fumigating Committee also did signal service by washing, whitewashing, and fumigating houses; while dunghills and other nuisances were swept away. The disinfectants used were chlorinated lime and sulphuric acid, as still used in the Sanitary Department of this city.

Soup-kitchens, too, were opened all over the city, and their products were unstintingly distributed; and last, but by no means least, a voluntary subscription was opened, and very quickly a sum of £8,000 was collected, this being supplemented later on by an assessment of the inhabitants which raised £6,000, making a total sum of £14,000, exclusive of assessments in the Barony and Gorbals Parishes.

The committee then issued a bill of advice and instruction, of which the following is a copy:—

“Advice by the Medical Committee of the Board of Health, regarding prevention and domestic treatment of Cholera.

“PREVENTION.

“*Cleanliness.*—Personal cleanliness must be attended to—artificers, particularly working at dirty trades, should frequently wash their bodies with soap and water—body-clothes, especially those next the skin, and also bed-clothes, should be often washed. Impure air is injurious, therefore houses should be well-aired, and every kind of filth, particularly in concealed places, should be instantly removed.

“*Dress.*—Warm clothing, consisting of under garments of flannel, and worsted stockings, should be used and should be cleaned once a week. The benefit of flannel cannot be supplied by the substitution of any other material. Wet, especially at night, should be avoided.

“Damp feet are very injurious.

“*Intemperance.*—The use of intoxicating liquors is hurtful, and is dangerous, if carried to excess.

“*Diet.*—Whatever article of diet is difficult of digestion, or is found by disorder in the bowels to disagree with the individual, should be carefully avoided. Raw vegetables, undressed fruits,

watery potatoes, should be avoided, and vegetables when used should be thoroughly boiled. Butcher meat too long kept, and spoiled fish particularly, ought to be shunned as highly prejudicial. A nourishing diet, regular both as to time and quantity, and moderate exercise, without fatigue, all strengthen the body, and fortify it against this disease.

“ TREATMENT.

“ Cholera usually begins with giddiness, great languor, and more or less uneasiness in the bowels, attended generally with looseness. Feelings of this kind should not give alarm at present, for they are common in all places and at all times. When, however, the disease prevails, the symptoms above-mentioned should never be disregarded, and an immediate call should be made for medical aid. But, as this often cannot be instantly obtained, the three following parts of domestic treatment should be put in practice. The procedure is at least safe and can do no harm, though the disorder should turn out not be Cholera:—

“ *Emetic.*—Two teaspoonfuls of mustard powder and a tablespoonful of common salt, mixed in a mutchkin (imperial pint) of lukewarm water, should be swallowed instantly. This will produce vomiting, which should be encouraged in the usual way, by repeating draughts of warm water.

“ *Draught.*—When the vomiting has ceased, forty drops of laudanum should be given in a little toddy made with half a wine glass of brandy, or good British spirits.

“ *External Heat.*—Every possible means of applying heat to the surface of the body, should be steadily had recourse to. The patient should be wrapped in hot blankets; hot bricks, bottles full of warm water, flannel or muslin bags filled with hot sand, bran, or salt, should be carefully applied to the trunk and limbs, using at the same time continual friction with warm flannel to those parts not covered with the bags. The sand, bran, or salt may be heated on a girdle, or in a frying-pan.

“ These applications should be persevered in without interruption, till a medical person arrives, who will direct the other management according to circumstances.”

This leaflet was freely distributed in all parts of the city.

The services of the District Surgeons, Drs. Stirling, Bryce, Johnston, and Messrs. Millar, Connel, Robertson, Paterson, Watt,

Panton, Dick, Easton, and M'Tear, were also called into requisition, they being assisted by several students of medicine.

These arrangements having been completed, the first case appeared, as has been said, on the 12th February.

The disease spread throughout the city and suburbs, and patients died on every side during the months of February, March, April, until the end of May, when a distinct lull occurred. About this time (4th June) there was a huge procession in Glasgow to celebrate the passing of the Reform Act of that year. Immediately thereafter the disease renewed its virulence, and continued through June, July, August, September, until the end of November. On the 5th of that month a notice was placed in the *Herald* to the effect that "The Board of Health have resolved to shut up the hospital in Albion Street, and discontinue the publication of the daily official reports. The Barony Board of Health have adopted a similar resolution." (Cleland, page 318.)

"The victims were interred soon after death, without ceremony, being attended only by persons appointed by the Board of Health for that purpose."

The cholera "caravan" was daily seen in all parts of the city. Horror prevailed everywhere. No wonder, then, that the city was thrown into the deepest gloom. No wonder that the theatre and other places of amusement were shut, that Sabbath evening sermons were discontinued, and that the ordinary social intercourse was temporarily abolished. (Cleland). Another writer has, however, quite a different picture of the time. Wallace, in his *History of Glasgow*, page 99, says "in spite of all the suffering and death, the affairs of the city went on without serious interruption. People bought and sold, married and were given in marriage, held balls and parties in the Assembly Rooms, Tontine Black Bull, and other hotels, squabbled over municipal affairs; and, above all, fought for and rejoiced over Parliamentary Reform, as if the destroying angel of death were not in their midst breathing in the faces of hundreds and thousands of their fellow-citizens."

The population at this time was 202,426, and the number of cases at the 5th November known to the authorities was 6,208, or 1 in 32½ of the population. The number of deaths was 3,166, of which 1,419 were males, and 1,747 were females. The total number of deaths for that year was 9 654 of which 3,718 were under ten years of age.

The disease seized one victim for every six, and there was one death in every thirteen families, the mortality being highest in the month of August, there being 1,222 burials in that month from all causes.

The mortality was chiefly confined to the intemperate, the dissolute, the ill-fed, and ill-clothed part of the population, but the disease did not spare even the better-circumstanced classes.

A day of fasting was held in Scotland on the 22nd of March, by order of the Privy Council, on account of the cholera.

Prior to the 16th April the arrangements for competing against the epidemic were centred in the Board of Health, but after that date it devolved upon the committee to carry out the orders of the Privy Council, and the two Acts of Parliament which were passed for the prevention of spasmodic cholera.

Thus terminated the first experience of Glasgow of that much dreaded plague—cholera morbus, as it was then termed.

The next epidemic with which Glasgow was seized is that known as the Typhus epidemic of 1837. This year was known as a year of commercial depression in the city, and of destitution among the poorer classes. The sanitary surroundings of these poor people was something indescribable—overcrowded dwellings, privies and dunghills cheek by jowl with living apartments, etc. Add to these factors destitution, and you get the components for a typhus epidemic. From the returns published by Henry Paul, Esq., Convener of Committee of Council on Churchyards, etc., we find that in this year, out of an estimated population of 253,000 persons, there were 10,270 deaths, of which 4,302 were under ten years. Of the total number, fever caused 2,180 deaths, and the estimated number of cases of fever, calculated on a mortality of 1 in 10, was 21,800.

It is very evident, however, that fever prevailed in Glasgow to a considerable extent in 1836 also, for in a table given by Dr. Watt in his returns for 1842, page 82, we find that while in 1837 there were 5,387 cases admitted into the Royal Infirmary, 688 died, in 1836 3,125 were admitted, of which 380 died; the percentage of deaths to cases in 1836 being 12·16, in 1837, 12·77.

This gives a fair index of the extent of the prevalence of fever in the city. The disease, although still continuing, had somewhat slackened in 1838, for we find that only 2,173 cases were admitted to the Infirmary, of which 245 died; rate per cent. of deaths to

cases being 11·27, while the total deaths in the year from fever numbered 816.

One historical fact in the history of the diagnosis of fevers was established during this epidemic, and it is one which calls for a little attention on our part, as it has given rise to not a little controversy.

The honour of differentially diagnosing typhoid or enteric from typhus fever has been divided between Dr. Alexander P. Stewart, of London, and Dr. Perry of Glasgow.

During the present year (1886) there has been published by the New Sydenham Society a volume in which is contained a “‘Paper on Typhus and Typhoid Fever,’ read before the Parisian Medical Society in April, 1840, by Alexander P. Stewart, M.D.,” edited by Dr. Cayley of London, which throws a direct light upon this vexed question.* (Vol. cx., p. 159, *et seq.*)

Dr. Stewart held the appointment of House-Surgeon at the Infirmary where Dr. Perry was one of the physicians, “and it was here that he made those observations which convinced him of the specific distinction of typhus and typhoid fever.” (p. 222.)

Dr. Stewart says:—“During the summer and autumn of 1836 the cases of typhoid fever were numerous (in the Glasgow Fever Hospital); from the month of November in that year (at which time both the type and amount of typhus became much more formidable) till June, 1838, the period that my connection with the hospital ceased, not more than a dozen cases—if there were even so many, and these at long intervals—were admitted for treatment.” (p. 162.)

In 1835 Dr. Peebles, a gentleman well acquainted with the appearance of the contagious typhus of Italy, visited the Infirmary, and in presence of Dr. Stewart, pointed out to Dr. Perry the characteristic rash of that disease in a patient, and from that time forward Dr. Perry “taught the difference between contagious typhus and dothienenteritis, and he appears to have been the first in this country to have done so.” But the internal evidence of the paper published by Dr. Perry in 1836 does not betray the fact that he recognised the disease—dothienenteritis—as a separate specific fever “accompanied by a rash of its own, but as an affection which might complicate other diseases as typhus and small-

* This paper was also published in 1840 in the fifty-fourth volume of the *Edinburgh Medical and Surgical Journal*.

pox, or occurs independently. Subsequently, he appears to have recognised and taught the distinction between the two rashes." (p. 161.)

When Dr. Stewart, in 1836, began the study of fever in Glasgow, he says, p. 161 :—" I was much struck with the simultaneous occurrence, in the ward of the Glasgow Fever Hospital, of two sets of cases, in which the symptoms (however little most of them might seem to differ when viewed individually) presented, when taken collectively, characters so marked as to defy misconception, and to enable the observer to form with the utmost precision the diagnosis of the nature of the disease, and the lesions to be revealed by dissection, it was more remarkable still, that, to complete the contrast already so striking, dissection proved the existence in the one disease of most extensive local lesions, in the other, the absence of all prominent local lesions whatsoever."

The leading characteristics of the epidemic of 1836 were "the red, chapped, and papillar tongue, the dull, circumscribed, abdominal pain existing for weeks together, along with constant diarrhoea, harsh skin, and obstinate bronchitis." This would undoubtedly point to enteric fever.

The epidemic of 1837 was, however, typhus, and it was extremely contagious.

" It is well known that for many years past," says Dr. Stewart, p. 168 (before 1840), " every resident clerk in the Glasgow Infirmary, with very rare exception, many students who frequented the fever wards, several of the acting physicians, and almost all the nurses, have, at one time or other, been attacked with typhus, and that not a few have fallen victims;" so also with the district surgeons, who attended the poor in their homes.

This paper of Dr. Stewart puts clearly the difference between the two diseases, and he deserves the honour of having been, if not the first, at least among the first, to put on a rational basis the main differing features of these two fevers.

It is also well to note that he acknowledges the value of the information imparted by Dr. Peebles during his visit to Glasgow in 1835 regarding the rashes, and puts that information to practical purpose in discussing their nature and appearance in his paper.

The last word to be said in this matter can only be that, while he (Dr. Stewart) was the first to scientifically prove the difference between typhus and typhoid, he shared the discovery with his chief, Dr. Perry.

But although his views were thus early given to the profession, they did not gain general acceptance until the famous papers of Sir William Jenner, then Dr. Jenner, in the *Medical Times* for 1849-51.

To return, however, the disease must have fairly well burnt itself out in 1838, for we find that, in an assumed population of 263,000, the total deaths were nearly 3,000 less in number, the exact figure being 6,932, the deaths from fever being only 816.

Typhus fever, however, continued to exist in the city in the worst parts, but gradually subsiding; the number of deaths in 1841, in a population of 282,134, being only 539.

Again, in 1842, the fever flame got rekindled, but the kind of fever was different. Fuel was added to it by the destitution which prevailed in the city in the following year—1843—on account of commercial depression.

So great was the destitution that a voluntary subscription was started for the purpose of meeting and combating it. Dr. Watt, in his Returns for the years 1841-2, p. 104, tells us that “during the year 1842-3 the amount of collections, subscriptions, and donations received was £12,550, which was expended upon giving outdoor and indoor labour, money and provisions to the destitute poor, and establishing soup-kitchens. The fever reached its maximum intensity in 1843, although it continued to rage during the succeeding years.

This is well shown by the total deaths in 1841-2-3-4—

	Total Deaths.
1841,	9,605
1842,	8,019
1843,	10,380
1844,	8,092

The sanitary condition of those districts of the city from which the fever cases principally came in 1844 has been very well described in the following passages from a paper by Dr. Perry. He says, there was an “overcrowded state of the houses, families of six, eight, and ten individuals crowded into one small apartment, without a bed to lie upon, if we except, perhaps, a quantity of long-used straw or filthy rags, emitting a stench of human impurity so offensive that, to one unaccustomed to it, is wholly insupportable, but to which the wretched inmates, from habit, appeared totally insensible; those small apartments, being often let by the week, are filthy in the extreme.” (Dr. Perry—*Facts*

and Observations, etc.) Take this also from the Report on Glasgow in 1842 by the late Dr. Farr :—

"It was found that the great mass of the fever cases occurred in the low wynds and dirty narrow streets and courts, in which, because lodging was there cheapest, the poorest and most destitute naturally had their abodes. From one such locality, between Argyle Street and the river, 754 of about 5,000 cases of fever which occurred in the previous year were carried to the hospitals." He then gives the account of a visit made on the 24th September in one of these districts. He says, "we entered a dirty low passage like a house door, which led from the street through the first house to a square court immediately behind, which court, with the exception of a narrow path around it leading to another long passage through a second house, was occupied entirely as a dung receptacle of the most disgusting kind. Beyond this court the second passage led to a second square court occupied in the same way by its dunghill ; and from this court there was yet a third passage, leading to a third court and third dungheap. There were no privies or drains there, and the dungheaps received all the filth which the swarm of wretched inhabitants could give ; and we learned that a considerable part of the rent of the houses was paid by the produce of the dungheaps. Thus, worse off than wild animals, many of which withdraw to a distance and conceal their ordure, the dwellers in these courts had converted their shame into a kind of money by which their lodging was to be paid. The interiors of these houses and their inmates corresponded with the exteriors. We saw half-dressed wretches crowding together to be warm ; and in one bed, although in the middle of the day, several women were imprisoned under a blanket, because many others had on their backs all the articles of dress that belonged to the party, and were then out of doors in the streets." "Truly," does Dr. Farr add, that "this picture is so shocking that, without ocular proof, one would be disposed to doubt the possibility of the facts." (Papers on Public Health by Dr. E. Duncan in *Glasgow Medical Journal*, July, 1882, p. 11, et seq.) (Royal Sanitary Commission of Enquiry into the condition of large towns.)

The account of the city, too, as given by the District Medical Officer, in the appendix to Dr. Perry's paper, is something so appalling, that one can hardly realise it.

The fever of this epidemic differed from typhus in respect to its symptoms and mortality; typhus killing near one half of those

seized, this fever "only from three to four per cent. with or without treatment."

Dr. Perry denominates it as a "peculiarly distressing epidemic fever, accompanied with severe headache, vomiting of bilious matter, and yellowness of the eyes and skin, several cases were admitted into the hospital as cases of jaundice. . . .

. . . It attacked in preference and most severely the broken-down and destitute, and was most severe in those whose constitutions were naturally weak, or had been reduced by want, by age, by disease, or intemperance." (Dr. Perry, *Facts and Observations on the Sanitary (sic) State of Glasgow during the last year, 1843.*) The disease was *relapsing fever*. The number of estimated cases from May till 30th December, 1843, was 32,000.

The estimation of cases per month is as follows:—

May,	510	Brought forward, 9,576
June,	1,143	October, 1,930
July,	1,284	November, 1,275
August,	3,649	December, 1,370
September,	2,990	
		Total, 14,151
Carry forward, 9,576		
Infirmary Cases,		641

Add to these figures 12,967 cases which occurred in 1842, together with 736 cases of typhus, with 1,194 cases which were treated in the Infirmary in 1842—(Watt's Table for 1842, p. 82)—with an allowance for those cases treated privately, and those not known officially, and we get a total closely approximating to that already given.

The following table given by Dr. Watt shows well the distribution of the estimated cases:—

District.	Population.	Cases.	Average per Cent.
City District,	118,000	14,000	12·00
Calton, Bridgeton, Camlachie, Wilton (sic) Milton? Blythswood, and Anderston,	99,000	7,000	7·00
Gorbals and Tradeston,	48,000	2,000	4·50
Remainder of Barony Parish, in the Suburbs beyond the Boundary,	10,000	500	5·00
Cases treated by private Practitioners,	—	5,500	—
Infirmary,	—	3,000	—
Totals,	275,000	32,000	11·63 per cent. of population.

The mortality of the disease is well illustrated by the following fact:—Of the 12,967 cases in 1842, 12,397 of these were treated at home, and of these only 304, or 2·36 per cent. died. (Perry.) According to Watt, the total deaths from fever—not typhus—in 1843 was 1,398.

Seeing that overcrowding was doubtless one of the main causes of the spread of the disease, the Authorities, in the Police Bill of 1841, obtained powers to put a check to this in Calton, “one of the suburbs of Glasgow.” A similar Bill was obtained for the city two years later, in 1843—(for at this time Calton was a burgh barony, and was not united to Glasgow, as in like manner were Gorbals and Anderston till 1846)—in which the number of lodgers in common lodging-houses was regulated and put under the control of the superintendent or other officer of the police. (Watt, 1843-44, p. 113.)

With overcrowding there is generally associated uncleanliness, and Dr. Kennedy, one of the district surgeons, in reply to queries by Dr. Watt anent the cause of the disease of 1843, says, in a letter dated 27th January, 1844, that although destitution seemed to be the prevalent cause, “much of the disease of the past year has arisen from the filthy habits of the poor.”

The city seemed in 1845 to have somewhat recovered from its epidemic of the former years, there being a fall of the total death-number to 7,509.

But, again, in the latter end of 1847, typhus began to rage, and in December it raged with its greatest virulence.

In that year, according to Dr. Strang, of a population of 344,200 persons, the total number of deaths was 18,886.

The fever continued into the early months of 1848, known as the year in which Glasgow was visited for the second time by cholera.

The summer and autumn of 1848 were signalised by an epidemic of scarlatina of a severe nature, and November and December saw the city in the midst of the cholera.

Out of an assumed population of 355,800, there were this year 13,179 deaths, or 1 in 28·5, while the rate for the previous year was 1 in 19.

Of the 13,179 deaths 5,232 were under ten years.

Of this number there died of Bowel Complaints,	.	1,237
“	Cholera,	1,420
“	Decline,	2,111
“	Fever,	1,387

Let us briefly glance at the history of the second advent of cholera.

Hull was the first point on the British shores attacked by the disease, which was again imported by a steamer from Hamburg, which arrived about the beginning of October. It quickly spread to London, Edinburgh, and arrived in Glasgow in the first half of November. (Hirsch's *Handbook of Geographical and Historical Pathology*, vol. i. p. 405.) Some say the exact date was the 14th of November, but the *Glasgow Courier*—a paper of that day of importance—mentions the date as the 11th. According to this paper, the number of cases from the latter date till 1st January, 1849, was 1,642. It was then prophesied that an increase in the number would result from the festivities of the New Year season, which proved correct. The number, 1,642, was not, however, nearly the whole number, because we find that in 1848 there were 1,420 deaths—that is, in a period of fifty days.

The *Courier* gives the figures, from which the following table is compiled, for the month of January, 1849:—

DATE.	DEATHS.		RECOVERIES.		Remaining:	
	Cases since last Report.	Since 11th Nov.	Since last Report.	Since 11th Nov.		
Jan. 1,	95	1,642	48	766	11	265
.. 3,	202	2,011	71	909	38	267
.. 5,	239	2,456	67	1,038	72	521
.. 8,	174	2,954	64	1,206	67	694
.. 10,	113	3,230	41	1,297	51	806
.. 12,	68	3,390	33	1,362	45	913
.. 15,	53	3,561	20	1,435	53	1,044
.. 17,	59	3,682	26	1,480	48	1,122
.. 19,	39	3,771	18	1,517	29	1,175
.. 24,	63	4,038	19	1,809	32	1,325
.. 26,	33	4,129	9	1,637	21	1,376
.. 29,	44	4,282	14	1,678	26	1,441
						...

REMARKS.

- Jan. 1.—Places also affected were Rutherglen, Airdrie, Holytown, Barrhead, Old Kilpatrick, Edinburgh, and Dumfries.
- .. 3.—Effects of holiday-drinking, and intercommunication at this period.
- .. 19.—Figures are incorrect for this entry because “the doctors have not regularly given in the returns of those cases which fell under their practice.”
- .. 29.—Returns after this date imperfect and irregular.

The duration of this epidemic was shorter than its predecessor of 1832, but it was more decisive. It began on 11th of November, 1848, and the last case was reported on 22nd March, 1849—a period of four months and eight days. The number of deaths during this period was 3,923—1,420 happening in 1848, and 2,503 in 1849. The population in this year was assumed to be 367,000, evidently an over-estimate, because we find that in 1851, the census year, it only numbered 360,138; but calculating at the assumed figures, it carried off 1·06 per cent. of the whole population. This percentage seems smaller than that of the epidemic of 1832, but it is only apparently so, because the increase of population must be borne in mind.

There was another difference between the two epidemics. Whereas that of 1832 chiefly affected the lower classes, that of 1848-49 attacked a very much larger proportion of the well-to-do classes inhabiting better houses, with presumably better sanitary surroundings. As Dr. Strang says—"On the former occasion the malady was chiefly confined to the lower and more densely peopled portions of the town, and was generally found among the more destitute of the population. On this occasion, however, it threw a gloom and mourning over the best habitations of the wealthy, and was comparatively careless of the more abject inmates of our more crowded hovels." (*Report, March, 1849.*)

In 1849, as has been said, the total deaths amounted to 13,731; the deaths under ten years to 6,298. Of the total number, the following complaints produced these deaths:—

Bowel Complaints,	1,385
Cholera,	2,503
Fever,	418

If we compare January, 1848, with the same month of 1849, it will give us a better idea of the fearful state the city was in. Thus, in January, 1848, there were 1,679 deaths; in January, 1849, 3,101 deaths, showing a mortality in the latter period *nearly double* of the former.

The mean burials, including typhus, from 1841-6 inclusive, was 1 in 33·4 of estimated population, while in 1849 it was 1 in 32·7.

Comparison of epidemics of 1832 and 1848-9—

Population.	Deaths from Cholera.	Per Cent.
1832, 203,000,	3,005	1·4.
1848-9, 367,000 (estimated), or 355,800,	3,293 ...	1·06. or 1·1.

It will never be known how many cases of cholera there occurred in the latter epidemic, but if we reckon in the figures given for 1832, viz., 6,258 cases, and 3,166 deaths, or a mortality of a little more than 1 in 2, we can say that the approximate number of cases in 1848-49 was at least 8,000.

As regards fever it will be seen, from the number of deaths recorded from this cause, that it has very much subsided in 1849.

During this year—1849—there arose a great popular outcry about the burial of cholera patients in such large numbers in the intramural burying grounds, notably those of Bridgeton, St. Mary's in Abercromby Street, and Calton.

Owing to the sudden demand for burial space, single or separate interments were impossible, and the dead were simply buried in huge pits. This shocked popular sentiment, and to meet this an enquiry was instituted, and evidence led showing the impropriety of this mode of burial. This evidence was of such an alarming nature that these burial grounds were closed, and prohibited as common places of interment.

The death rate of the city fell more to its normal state during the next three years, but it was not to remain long free of its most terrible enemy—the cholera. “It again came from Germany to England to a number of seaports, including Gateshead and Newcastle, Shields, London, and Liverpool; somewhat later it occurred also in Manchester, Edinburgh, Glasgow, and Dundee, lasted in those places throughout the following winter, and attained a wide distribution over the whole of Britain the year after.” (Hirsch, *op. cit.*, vol. I., p. 409.)

It appeared in Glasgow about the middle of December, 1853, raged during the early months of 1854, temporarily ceased in May, only, however, to again as seriously as at first break out in the beginning of June; continuing during the summer months, culminating in August, and dying in December. It thus practically lasted a whole year.

The records of this epidemic are extremely few, the nation and the city being exercised deeply over the result of the war between Great Britain and the Allies and Russia. While thousands were dying in the trenches from the effects of improvidence and the results of war, the deaths of thousands in their own midst seemed to bulk little in their mind.

The number of deaths from that epidemic was, so far as known, 3,885, of which no fewer died in August than 1,023. The date

of its temporary cessation—when the city was reported free of the malady—was the 12th May, after which date no reports were given in the *Mail*, and the date of its revival was about 1st June.

In this year, too, there were epidemics of measles, whooping-cough, and scarlatina. Of measles there died 1,040, of scarlatina 908, of typhus 703, of whooping-cough 839, and of cholera 151.

The large number of 7,046, or 49·23 per cent. of the whole deaths, died under the age of five.

The next epidemic of any note was one of typhus fever, occurring between 1864 and 1865.

Then there was a trifling seizure of cholera in 1866, but fortunately the number of deaths was only 53.

The next epidemic calling for attention is that of 1870-71, of relapsing fever—the second time within these last hundred years that it visited our city.

During this year, of a population of about 490,000 the number of deaths within the municipal boundary was 923, added to which is 33 deaths occurring beyond boundary, making a total of fever deaths of 956.

The first cases of this fever were reported on the 18th August, 1870, in four persons of one family residing in Muirhead Street. After this it spread gradually over the city, while typhus remained quiescent.

The total number of cases reported to the Sanitary Office was 7,564; the number of hospital cases being 4,793, with 397 deaths; and of private cases 2,771, with 526; while the number of cases outside the boundary is unknown, the deaths, however, numbered 33.

In this year, also, there were 473 deaths from scarlet fever, 129 from measles, and 18 from smallpox. And the total number of all known cases of infectious disease of every kind in the city was 11,861. The total deaths were 14,646.

Into 1871 the fever continued, the number of cases in January amounting to 1,446, lessening in number up till September and October, when there was a slight increase, while the smallest number occurred in December, being only 420. The total number of cases of fever was 8,029, chiefly relapsing fever, while the total number of cases of death from continued fever was 787; the total deaths of the city amounting to 16,155, in a population of 490,442.

Besides relapsing fever, there was a very sharp epidemic of

smallpox. The number of cases reported to the Sanitary Office was 1,089, of which 205 died.

From the number of deaths it was presumed that there existed a much larger number of cases than those reported.

There were also epidemics of measles and whooping-cough, the former causing 889 deaths, the latter between five and six hundred —540.

Of the epidemic of relapsing fever it is interesting to note that it originated in London, and gradually spread northward till it reached this city, as has been said, in August, 1870, and reached its climax of severity in December of that year, when 1,558 cases were reported.

In 1872 there was a severe epidemic of whooping-cough, which caused 1,056 deaths, while the deaths from smallpox had fallen to 137, and from continued fevers to 430.

In 1873 the number of deaths from smallpox and scarlet fever again rose, the former amounting to 223, and the latter to 602; there was a marked increase over the former year of deaths from measles, the number being 614, while the deaths from continued fever had fallen to 340.

The year 1874 was distinguished by a serious outbreak of scarlet fever, the number of deaths rising to the high figure of 1,719, and the deaths from whooping-cough also rose to 676. The epidemic of smallpox still continued, for we find 221 deaths recorded from this cause.

The epidemic outbreaks of typhoid fever which have occurred in Glasgow since 1875 have all been traced to poisoned milk imported into the city from farms in the country. In that year (1875) occurred the Washington Street epidemic, chiefly affecting the Anderston district, during which "58 cases of undoubtedly typhoid, and 30 cases of a feverish illness, suspiciously like typhoid" presented themselves (Russell). The number of deaths from continued fever in this year rose to 382, from scarlet fever fell to 729, and from whooping-cough rose to 692, while from smallpox the number fell to the pleasingly low figure of 2.

The year 1876 presented nothing unusual in the way of epidemics, but in the following year (1877) occurred the West-end typhoid epidemic. Of 122 families supplied more or less exclusively from one dairy from which poisoned milk was dispensed, 29 were affected with the disease.

The only point of note in 1878 was a doubling of the mortality

from whooping-cough; in 1877 the deaths from this cause were 424, but in 1878 they rose to 985.

The next year (1879) presents nothing of more than ordinary interest, but in 1880 arose another of these typhoid epidemics from tainted milk, much more severe and widespread than any of the previous ones. From 1st April to 29th May, 508 cases presented themselves in 372 families, of which 69 died, 62 in those districts lying north of the Clyde. It is of interest to note the statistics of the city from 1861 to 1880 inclusive:—

In the decade 1861-70 the mean death-rate was 30.29 per thousand of the population. In the second decade, 1871-80, the mean death-rate was 28 per thousand, the mean population being 513,910, and the mean number of deaths per annum 14,425. This difference in the death-rate between these two decades means this, that 10,000 persons were alive at the end of 1880, who, if the death-rate had remained as in the first decade, would have been dead.

Dr. Russell has pointed out, too, this very satisfactory fact, viz.:—That the lowest mortality of the two decades is to be found in the last five years of the second decade. This is well shown in the following table:—

PER 1,000 OF POPULATION.

	Years. 1861-70.	Years. 1871-75.	Years. 1876-80.
Fevers,	20	9	5
Smallpox,	2	3	7
Scarlatina,	13	15	5
Measles,	8	8½	5½
Whooping-cough, . . .	15	13	12
Croup and Diphtheria, .	6½	6	5½
Diarrhoeal Diseases, . .	8	9	7*

* This would have been four (4) but for the enteric fever epidemic of 1880.

During the years 1871-75 the number of deaths from pulmonary diseases was 26,635; during 1876-80, 24,296; total number in

the decade 1871-80, 1881-90. This is the only unredundant in the second and in the third. In the years 1861-70 poliomyelitis caused 4 per cent. of the total deaths; the years 1871-80, 14 per cent., and the years 1879-90, 26 per cent.

Dr Russell says at this:—“We have not yet strayed against the causes of our pauperistic death-rate, which atmosphere suffocated with smoke and stroped in its perniciousness by over-density of building, and overcrowding inhabitants with a low evel of household comfort.”

NOTES AND REMARKS ON TABLE.

SOURCES OF STATISTICS.

(a) From 1783 to 1830 inclusive. Dr. Robert Cowan's MS. Papers in *Transactions of Glasgow Medical Society*, except from 1812 to 1821 inclusive, which are left out for reasons mentioned in *Remarks* on margin of Table.

From 1822 to 1831. Cleland's Report for 1831.

(b) From 1831 to 1839. From Table of Henry Paul, Esq., Actuary, Magistrate of Glasgow.

(c) From 1839 to 1846. Dr. Watt's Tables.

(d) From 1847 to 1855. Dr. Strang's Table.

(e) From 1855 to 1860. West Watson's Reports for 1865, p. 9.

(f) From 1861 to 1870. Table by Dr. Gairdner, Medical Officer of Health.

(g) From 1871 to 1880. Table by Dr. Russell, Do.

(Philosoph. Soc. *Trans.*, Vol. XIII., p. 344.)

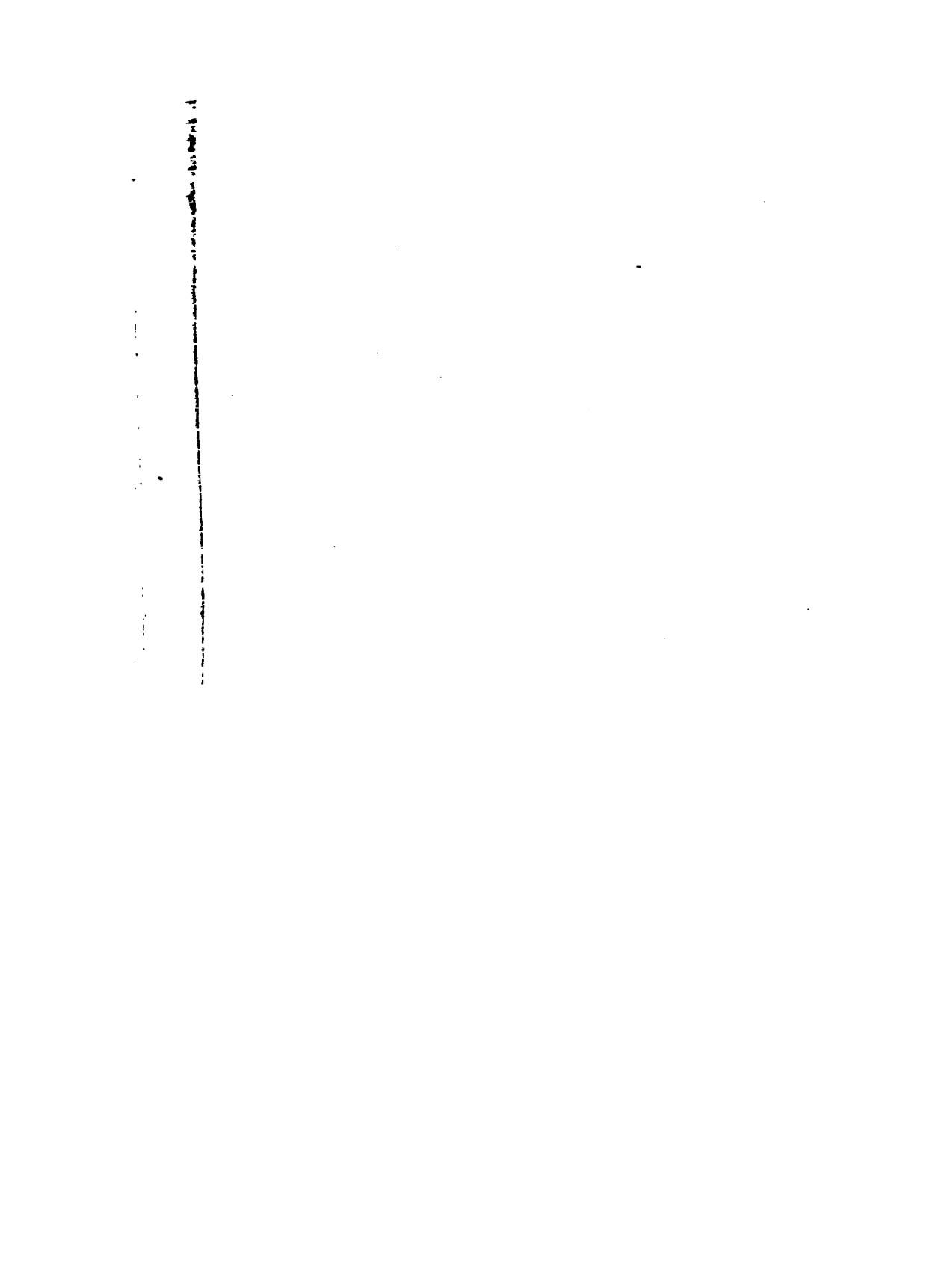
(h) From 1881 to 1883. Nicol, City Chamberlain (*Vital, etc., Statistics*, 1881-85, p. 32).

MODIFYING FACTORS OF FIGURES GIVEN IN TABLES.

1. Those marked thus—(a), and those populations other than at Census years, 1801, 1811, 1821, 1831, 1841, 1851, 1861, 1871, and 1881, are *assumed populations*.

2. From 1783 up till 1853, deaths under *Ten* were separately calculated. From 1853 till 1883, deaths under *Five* are calculated.

Note.—In working up the number of deaths annually from 1783 till 1855, it is to be noted that the Still-births had to be separated from *post-partum* deaths. Frequently erroneous calculations had been made in former Tables in reckoning the death-rate, on account of the Still-births being slumped with the *post-partum* deaths; these calculations ought to be called “Burial-rates.” This has been avoided in the foregoing Table, but Cowan's figures had to be adjusted because of this.



XXI.—*On an Automatic Photo.-Printing Machine.* By JOHN
URIE, 83 Jamaica Street, Glasgow.

[Read before the Society, 14th April, 1886.]

IN bringing before you to-night this latest improvement in the art of photographic printing by artificial light, I may state that hitherto the great drawback to the advance of the art has been the slow method of obtaining impressions from the negatives; and I may say that almost no advance has been made in the system of silver printing on paper for nearly fifty years; indeed, the original process introduced by Fox Talbot, the inventor of photography, is the universal method practised at the present time.

By this old slow method of printing, photography has been unable to compete with the sister arts of engraving and lithographing; in the winter months almost bringing the operations to a standstill. You may imagine what speed could be made in taking off a large number of copies when I tell you that not more, on an average, than six impressions per day could be obtained from one negative, and during the winter months often taking as many days to print one copy.

The object in introducing this automatic printing machine is to get over the many difficulties that occur in a developing process of printing upon the new sensitive paper, as the exposure to light is so short that a second of time more or less will completely destroy the tone or vigour of the print, and so the machine is arranged that any fraction of time from a second to ten minutes may be given, according to the density of the negative.

Perhaps no discovery of modern times has made such rapid strides as has photography.

The introduction of dry gelatine plates (prepared by spreading an emulsion composed of gelatine and bromide of silver upon glass plates) gave the photo-artist such a command over the objects to be taken—the exposures being so rapid, almost instantaneous—that a railway train in rapid motion, the fleeting of the

clouds, or the curling of the wave when breaking into foam may now be taken as sharp as if motionless.

Now if the coating on glass with a compound of gelatine and bromide of silver gave such a sensitive film, why not use the same preparation on paper? This is exactly what has been done. We find that a paper coated with an emulsion of gelatine and chloro-bromide of silver is nearly as sensitive as the dry gelatine plates; and I believe that impressions printed upon this paper should be far more permanent than those of the present time on the usual albuminized paper, as all the free salts are washed out of the emulsion before being spread on the paper. But the great advantage of this system of printing is that great numbers of copies may be thrown off in the shortest period of time. Indeed, a mere flash of light is sufficient to give a vigorous impression, and by using the ordinary gaslight there is no difficulty in throwing off two or three hundred prints an hour, and by daylight thousands instead of hundreds may be produced; and I believe there is no limit to the speed by which these impressions may be rolled off.

The advantage of this quick-printing process will be obvious to every one, as the negative may be taken, and in a few hours thereafter housands of copies may be supplied without the aid of the engraver or lithographic artist, and a far more truthful representation of the object desired. And for book illustration, mechanical, microscopic, and other scientific subjects, it will be invaluable as a source of educational advancement, far surpassing most of the crude engravings and lithographs at present in use. I may even go so far as to state that in the near future the Photographic Printing Machine may even rival the Steam Printing Press.

The machine invented to cause such a revolution in photography consists of a box about twelve inches square, and of double that length (or any other size that may be required). In a recess in the centre of the box is fixed a pad over which a band of sensitive paper sixty or seventy feet in length passes, as it is unwound from a spool at one end of the box on to a drum at the other end. Above this pad is a heavy metal frame with slide to hold the negative, this being hinged at one side so as to admit of its being raised to allow the sensitive paper to move forward at the end of each exposure; and above this in turn are two gas burners. Certain clockwork arrangements in the interior of the box acted upon by two weights give the motive power. The time

of exposure is regulated by the adjustment of a barrel in gear with the clockwork; round this barrel project a number of spikes which act upon a lever to lift the negative frame, and turn down the gas during the time the paper is shifting, thus, according to the number and arrangement of the spikes round the barrel, by which any exposure may be given from one second to ten minutes.

The action of the machine is as follows:—The clockwork when started turns down the gas to a very low point, the weighty frame containing the negative is raised to a height sufficient to enable the sensitive paper on the spool to be pulled forward a distance equalling the width of the picture to be printed, which is no sooner effected than the negative is again lowered on the paper, with which it remains in that close contact insured by the weight of its frame; simultaneous with this movement the gas flames are turned up to their full power, and remain so during the short period of impressing the print on the paper, as arranged according to the density of the negative. At the expiry of this predetermined period, down goes the gas, the negative being then raised, and the paper drawn forward the requisite distance, when the negative again resumes its place on the paper, the lights are turned up and the whole process of exposure re-acted until the long band of paper is finished.

As the machine is self-registering, the attendant may go away and leave it working, ascertaining on his return the precise number which have been printed during his absence. Provision is also made for the attachment of an electric bell to give the alarm when the desired number are printed.

To develop, the exposed paper is either cut in lengths containing thirteen prints, or in long bands, and is placed or rolled through a bath of ferrous-oxalate, by which the latent image becomes visible—at first faintly, though it soon acquires great vigour. The prints having been washed, are put into a bath of alum, in which they remain for a few minutes; if a warm tone be desired they are placed in a gold bath, the same as used for toning albuminized prints. The tone may be determined with accuracy, as the prints undergo scarcely any change when subsequently they are fixed with hyposulphite of soda.

It will be understood that one print is identical with another in vigour and tone, and these qualities are quite under the command of the operator.

As many as two or three hundred may be thrown off by one

machine, and by a more sensitive emulsion thousands of copies instead of hundreds may be done.

To those who still prefer the old printing process on albuminized paper they have only to run a band of Eastman negative paper through the machine, using a transparency instead of a negative, whereby they may multiply their negative to any extent.

The method of photography described in this paper is illustrated by the accompanying portrait of the President of the Philosophical Society, Dr. Henry Muirhead. (See Frontispiece.) The photographs were printed off at the rate of 500 per hour by one of the small automatic machines.

XXII.—On the Tribe of Beqa's alleged power of walking through Fire. Excerpt from Letter dated 22nd September, 1885, from the Honourable JAMES BLYTH, Secretary for Native Affairs in the Colony of Fiji. By ROBERT BLYTH, C.A.

[Read before the Society, 28th April, 1886.]

THE little island of Beqa, to which the letter I am about to read relates, is one of the 200 or 250 islands and islets which form the Fijian Archipelago. The colony comprises the whole group lying between the parallels of latitude of 15° and 22° south of the Equator, and between the meridian of longitude of 177° *west*, and 175° *east*, of the meridian of Greenwich. It is distant from Sydney about 1,900 miles, and from Auckland about 1,200 miles. It lies 300 miles north-east of the Friendly Islands, and 500 south-west of Samoa.

The whole colony has an area of 7,400 square miles, and it is therefore about one-fourth of the size of Scotland. The island of Beqa has an area of 13 square miles; it lies 6 miles off the south coast of Viti Levu, the largest of the group, but, though so near, it appears to be seldom visited by Europeans.

The following letter describes what my brother witnessed on the occasion of his first visit to the island, after a residence in Fiji of 15 years:—

“ Beqa is divided among two tribes, the Raviravi and Sawan; our Council was to be held by the chief of the former, but the latter is the root of any interest these few lines may possess.

“ It appears that long, long ago, before Lotu (Christianity) came, the Sawan people used to beguile the long nights by story-telling, and one night they drew lots (Vakawiri madigi) as to whose turn it should be to tell a tale on the evening following. The lot fell (that is, the cocoa-nut's eye, on the nut being twirled) on a young man, and the next morning he set out early to get prawns for supper — it being the duty of the story-teller to provide food. He proceeded along the shore, and upon turning up a stone in a small creek saw a small hole or opening that excited his curiosity; on further examination it proved to be a passage to a tunnel that

ran under ground, and he followed it, groping in the dark, being assured from certain signs—such as a small piece of *masi* (native cloth)—that it was the way to some habitation. After feeling his way for several yards he came to a wall, and passing his hand down he touched a man's toe, and passing his hand up he touched his knee; then he grasped the leg, and drew a man out to the daylight. A man! It was the god of *Sawan* whose home he had discovered. Fortunately he had cut a stout club that morning, and, as the god struggled, he raised it over his head as if to demolish him. Seeing what a fierce antagonist he had to do with, the god gave in, and, in piteous tones, said—'Save me! O save me!' Then occurred the following dialogue:—

"**GOD**—If you will only save my life alive, I will be the god of your armies; when you go to war I will fight on your side, and you will always be successful."

"**SAWAN MAN**—That won't do. We Beqa people don't require your help in war; we are strong enough without it."

"**GOD**—Save me, and I will be the god of your canoes; I will sail with you, and no storm will hurt you."

"**SAWAN MAN**—We fear no storm. We are all sailors in this island; I can manage my canoe without your help."

"**GOD**—Save me, and I will be the god of your planting; all your food shall grow well and be abundant."

"**SAWAN MAN**—Whose gardens are like the Beqa gardens? Who has yams like ours? We can do our planting without you."

"**GOD**—Save me, and I will be your god in love; all the women will love you."

"**SAWAN MAN**—I am happy in love at present. My love affairs are no trouble to me; I don't want any of your interference *there*.

"**GOD**—O save me, and I will be your god at the 'Veitiqa' (a game played by throwing darts). Your 'tiqa' (dart) shall excel all others."

"**SAWAN MAN**—It does so already. What next?

" And so on through many things, all of which were declined. At last the god said—'O save me, and I will shew you the secret of the 'Vilavilairevo' (literally, 'leaping on a hot oven')—corresponding in the Bau dialect to 'Rikarikalovo,' the former is the

Beqa vernacular). ‘Ah!’ said the Sawan Man, ‘that will do. Show me *that*, and I will spare you; deceive me, and you die.’ ‘Come, then,’ said the god, ‘I will put you in the Masawi oven for four days that your body may be prepared.’ ‘No, you don’t,’ replied his human enemy; ‘I don’t intend to be burned and roasted alive *that* way. Now die!’ ‘O spare me!’ said the god, ‘now I will tell you the secret.’ Then he told the secret, and afterwards he made a fiercely-hot oven, and the Sawan man walked through it unharmed, and all his descendants have had the power to do so ever since. That is the story. It had been told to me long ago over the Yagona bowl, and I had laughed joyously, but my informant was himself a Sawan man, and was piqued by my incredulity. ‘Don’t you believe me?’ he said, ‘I can do it, and I will, the very first time you go to Beqa.’

“This was my first visit to Beqa, and my friend was as good as his word. He did it; I saw it. You shall hear.

“All day on Thursday last they were cutting firewood. They then dug a pit about 6 feet deep and 16 to 20 in diameter. The scene was in a wood a quarter-of-a-mile out of the village. I accompanied the chief thither at two p.m. An immense concourse of people had assembled, and already the most vigorous preparations were being made.

“A fire had been kindled in the pit by small pieces of wood, and on the top were placed stones from the beach, some large, some small (averaging 10 to 12 inches in diameter), and piled high on the mouth of the pit. Around this pile were laid great logs of wood burning. I think the stones were made as hot as stone can be made. A number of men then approached with long poles and loops of vines at the end, and drew off the burning logs which had already done their work. The logs were very heavy, and many men had to assist, and there was great shouting, but in time all the logs were cleared away and the stones exposed. My friend, Jonacani, then walked slowly over them; then another and another followed deliberately. I was in the foremost rank, and not more than 12 feet from the pit’s mouth. I could see everything plainly, and my face was scorched by the heat. An immense shout arose from the assembled crowd, and for a moment I felt sorry that I had allowed the exhibition. I thought, and Jonacani evidently thought also, that the men who had come from the mainland were so excited that they would rush in and be burned, many instances having been recorded previously. Jonacani, how-

ever, soon restored order, and then placed a number of men round the oven with strong vines to protect it. He next ordered the men with the vines to pull down the pile of stones and lay them flat. This was soon done and one could see the red-hot stones beneath, and the curling flames of fire lapping them leisurely. The heat was now more intense than ever, and at this moment an opening was made in the crowd and a band of fifteen or twenty men and youths of this particular tribe stepped forward and walked hand-in-hand across the live stones ; then they turned and walked deliberately back. They had their usual clothes on—that is, a waist-cloth of print only, and some wreaths of leaves round their necks and shoulders, such as are worn at feasts and dances ; round their ankles and under their knees they wore fillets of a very dry kind of grass that is highly inflammable.

"After the second trip across they all returned, and grouped themselves in the middle and *stood!* And then fifty hands showered leaves over them, green leaves of the ivi and dawa trees ; these they caught and placed under their feet, but I saw no more, for the column of smoke that immediately arose was so dense as to totally obscure all that followed. I thought the men were suffocated, but presently my friend joined me and said—'Sa oti' (it is over). Then he continued—'And now what do you think of it ? Is it true, or is it a lie?' I said—'Let me feel the soles of your feet.' He held them up ; they were quite *cold!* Then I asked—'What ointment did you use?' 'None,' he answered, 'look for yourself.' I looked ; there was none, and not a hair singed, even on his very hairy legs ! 'Well,' he said, 'is it true?' 'It is true,' I answered, 'I have seen it.'

"I passed slowly back to the village with the crowd, who were expatiating on what they had seen, and now there was not one incredulous voice to be heard. Some said—'They know something that we do not ;' others—'Was the furnace that Shadrach, Meshach, and Abednego entered like this?' and so on : but not one doubted what their own eyes had seen.

"All the preparation I could hear of was that they all had to bathe in a particular stream on the morning of the day on which the ceremony was observed—but I cannot hear that the stream was anyway different from other streams. 'Borax!' you will say. I don't know ; I could see nothing at all. I examined the men's feet closely, and they were not wet nor anointed in any way visible to the naked eye."

XXIII.—*On the relative merits of Tile and Cast-iron Drain Pipes.*

By GILBERT THOMSON, M.A., C.E., Resident Engineer of the Glasgow Sanitary Protection Association.

[Read before the Society, 28th April, 1886.]

A DRAIN of any sort under a house is at best only a necessary evil. In detached houses, as a rule, it is possible for the architect so to arrange the fittings that no pipe need run actually under the house; but, on the other hand, it is scarcely possible in streets and terraces to make this arrangement, and though by careful design a great deal has been done, and still more will be done, to minimize the amount of such piping, we can scarcely hope to get rid of it entirely so long at least as the present system of sewage removal continues. Again, in reconstructing the drainage of an old house, the main features of the old system have often to be preserved, and in such a case it is usually fixed by circumstances that the drain must go under the house. Accepting this necessity, the problem to be solved is to render the drain as efficient and as safe as possible. I have no intention of saying anything about the well-known effects of bad construction. The time is fortunately gone by when a drain was thought to fulfil its functions admirably if the sewage passed away through it somehow, without giving evidence to the eye or to the nose, about the wretched apologies for joints, and the abominable state of the surrounding soil; and I am fully warranted in assuming that every one is agreed that the object of all who are in any way responsible for drain-laying should be to produce a channel through which sewage will pass unobstructed from the house, but through which foul gases cannot pass into the house.

With this assumption, my object is to bring before the Sanitary section of this Society a comparison between the ordinary method of making a first-class job and another which is by no means new, but still not common. The idea of using iron for house drains is one about which, of course, I make not the slightest claim for originality; it has been used for many a year, and has been recom-

mended by numberless writers, but it has not come to the front in the way it should. It would be unfair to compare the iron drain with the fire-clay drain common a few years since, and not altogether unknown now, where any labourer was considered competent to lay the pipes, any pipes good enough, cement a needless trouble, and rise or fall a matter of no importance; but compare it with a fire-clay drain, laid in the best manner, and without sparing expense. Such a drain is laid somewhat as follows:—The trench is first cut, and, if possible, levelled from end to end, then if the bottom is at all insecure, a layer of cement concrete or stone slabs may be put in. The pipes are presumably got from a maker of repute, and are at least free from glaring defects, such as broken faucets or large cracks. Beginning from the lower end, the first pipe is put in position, and carefully packed up at the shoulder, just behind the faucet; a trowelful of cement is laid in the faucet, and the next pipe is pushed in. The upper part of the joint is then filled with cement, pressed in with the trowel, or what is still better (not for the workman, but for the joint), with the fingers. The outside of the joint is finished off with the trowel, and the inside is cleaned out by a disc or half disc fixed on a rod—a lamp and mirror being sometimes used to see that this is properly done. The trench is left open till the cement sets, and the pipes are tested for tightness, sometimes by water, but generally by smoke. It is, in my experience, an unusual thing to find a line of pipes, say 20 or 30 yards long, in which some flaws are not found when tested in this way. These are due in some cases to defects in the pipes, such as kiln-cracks, but more frequently to damaged joints. If, for instance, a careless workman has walked along the pipes before the cement was quite set, every joint will probably leak. In good work, however, these defects are seldom serious, and are readily put right. The utmost has now been done to ensure that the drain will be a tight one, and a certificate that the pipes have been tested before being covered in is rightly regarded as the most satisfactory proof of their goodness. But the whole drain thus formed is practically rigid and inelastic, and will stand no movement without something giving way. After testing, the trench is filled in more or less carefully, and the earth is rammed down more or less firmly. For further security the pipes may be again tested; but while the former test was remarkably reliable, this one—if smoke is the agent—is quite the reverse. The idea is rather prevalent that the smoke test is

an infallible specific which, with a supreme disregard for all natural law, will tell exactly the state of the drain ; but it must be remembered that the sight or smell of the escaping smoke is the only clue to a defect, and that, after the drain is covered up, the chances are much in favour of a defect remaining undiscovered. In spite of that, however, cases are continually coming under my notice where pipes, which I had seen tested while open, showed decided leaks some time after when again tested ; and when first-class work has been expected and paid for, and, to all appearance, performed, such an occurrence is, to say the least of it, annoying to both proprietor and tradesmen, and forms a serious argument against the system. I quite admit that most of these leaks are trifling, and would probably be infinitesimal in their evil effects; but when every endeavour has been used to make a perfect job, the smallest departure from perfection is unsatisfactory.

It is not wonderful that attempts have been made to improve on that state of matters. One effectual improvement, still retaining the fire-clay pipes, is to lay them carefully as above described, and then to bury them bodily in solid concrete. This certainly does away with all fear of leakage, unless from some serious subsidence; but it is easy to picture the effect of a choke occurring in such a pipe after it has been laid for a few years. I never saw such a case, but it is a very possible danger, and the prospect of quarrying through a foot of concrete to reach a pipe which might be choked at the point first reached, or at any other, would be sufficient to deter me from the responsibility of recommending such an arrangement.

The other plan is to abandon the use of fire-clay inside the house altogether, and to substitute for it a pipe made of cast-iron. The superiority of this material seems to me to be clearly proved. In the first place, it is stronger, and much less likely to have unnoticed defects. The pipes can easily and conveniently be tested by a water-pressure applied to each pipe before use, enormously in excess of any possible working-pressure; and, as regards the finished drain, while I would hesitate to specify that a fire-clay pipe should be tested with a 6-feet head of water, I would have no hesitation in specifying, and tradesmen would have no hesitation in agreeing, that their iron pipe should be subjected to ten times that pressure if it were thought desirable.

In the next place, the joints are fewer in number, being at 6 ft. or 9 ft. distances in place of 3 ft., and are made either by staving

red-lead and hemp into the faucet, or by running melted lead in and then staving it up, a joint being produced in either case, which would stand any ordinary rough treatment.

Again, access can be provided by having flanged openings, round or oblong, covered with iron plates bolted firmly down on india-rubber rings; and as these can easily be taken off, they form a convenient means of regular inspection, as well as a safeguard against accidental chokage.

There is one particular case in which iron pipes have a special advantage over fire-clay pipes, and that is when, from bad foundations, or other reason, it is desirable to hang the pipes from above instead of supporting them from beneath. This can be done very successfully with iron pipes, while, of course, it is out of the question with tiles.

Now, as a set-off against these advantages, I can see several objections that may be urged. In the first place, it is a common objection that iron pipes have not such a smooth surface as fire-clay, and that, therefore, they are more apt to become dirty. I do not think that in a good ordinary iron pipe this is sufficiently marked to be a serious matter, and I have seen iron pipes opened after several years use, which looked almost as clean as when they were put in. The durability can only be fully proved by long experience, but so far there is little reason to fear on that score.

The other objection is the one which is practically serious, that is the expense. It must be admitted that the cost of iron piping is greater than that of fire-clay, but not to such a degree that in an ordinary case it should be prohibitory. Take, for example, the case of a house in a Hillhead terrace. I have an alternative estimate for taking up and renewing the drain in such a house, making good all connections underground, and renewing the asphalted surface. The one estimate, which is for fire-clay pipes, amounts to about £25, the other for lead-jointed iron pipes, with branches and access openings, about £32, that is to say, a difference of about £7. From other prices which I have got, I am inclined to think that in this case the extra expense is not under-estimated, and that the difference, as a rule, would be even less.

I have not thought it desirable to take up any time by referring to experiments that have been made with the two forms of pipe. The results, as far as I know, have always tended to show the great superiority of iron, and led the authorities of New York to enforce its employment inside houses.

Outside of the building, where absolute tightness of jointing is of less importance, fire-clay pipes are admirably adapted for drainage purposes, but for the inside, where we are prepared to go to great expense to secure a perfect drain, it is, I think, extremely illogical, and very false economy to stop at the comparatively small extra expense which the use of iron would involve. The continued use almost universally of fire-clay pipes is due, I think, more to an unexpressed conservatism than to a decided conviction that they are best, and my object is to endeavour to have the question decided on the grounds of reason rather than of tradition.

XXIV.—*The Physical and Biological Conditions of the Seas and Estuaries about North Britain.* By JOHN MURRAY, Ph.D., V.P.R.S.E., of the *Challenger* Expedition.

[Read before the Society, 31st March, 1886.]

THE physical and biological conditions of the shores, estuaries, and seas of the north-west of Europe are so largely determined by the phenomena of equatorial and tropical regions, that it will be instructive to review briefly some of the more general results obtained in recent years through the elaborate investigations of the great ocean basins.

Directing attention chiefly to the condition of things in the North Atlantic Ocean, it will be found that the knowledge we now possess of the state of matters in the deep sea contributes greatly to a right understanding of the various factors which produce, along our coasts and those of Scandinavia, the most abnormal of all the climates of the world.

The surface of the earth may be marked off into three great areas.*

1st. The continents, covering five-sixteenths of the earth's surface, and having an average height of 900 feet above the level of the sea.

2nd. An abyssal region, covering eight-sixteenths, or one-half of the earth's surface, and the average depth of which is three miles, or over 15,000 feet, below the level of the sea.

3rd. A region between these two, called the border or transitional area, covering three-sixteenths of the earth's surface, and connecting the great elevated plateau of the continents with the great submerged plain of the abyssal regions.

In the latter or border region deposits are now being laid down which are chiefly made up of the debris of the adjacent continents—

* These areas were represented on large equal surface projection maps.

deposits resembling in almost all respects those out of which the sedimentary rocks making up the present continents have been formed in past ages. In the abysmal area we have, here and there, small volcanic islands rising as great cones from the bottom of the sea, sometimes capped with coral reefs and forming atolls; but we have in this area no traces of continental rocks. Indeed, it is extremely unlikely that any continental land ever existed in these abysmal areas during past ages, and the deposits now forming in these abysmal regions far from the present continental land have, so far as we yet know, no analogues in the geological series of rocks.

While, then, there is no evidence that continents ever existed in the areas now comprised in the abysmal region, the ocean, on the other hand, has in past times flowed over nearly every portion of the continents. What are now continents have been broken up into islands of great or small size; and islands, like Britain, Japan, the Philippines, Australia, and many others, have at different periods of time formed parts of the existing continents. The changes in level which have been such characteristic phenomena of the continental and border areas throughout past geological ages have, at different times, permitted the formation of wide seas over these areas in a great many directions. These seas probably never had a depth nor an extent any more than at present comparable to the depth and extent of the great ocean basins, but they have often had a depth of many hundreds of feet, and were frequently filled with truly oceanic waters. The breaking up of the land in the way here indicated has been a chief factor in the distribution of climates in past as well as at the present time, for, by diverting equatorial oceanic currents to, or by cutting them off from, high northern or southern latitudes, climates have been rendered milder or more severe; and consequently a given fauna or flora has been able to flourish at widely different latitudes on the surface of the earth. Before proceeding to illustrate this remark by reference to the condition of things on our own coasts, it may be well to examine the general distribution of temperature in existing oceans.

In equatorial regions the surface water has generally a temperature ranging from 60° to 84° Fahr. The warm water is, however, a relatively thin stratum on the surface, the greater part of ocean water having a temperature below 40°; it is ice-cold at the bottom in the Atlantic even beneath the Equator, the ooze

dredged from the sea-bed beneath the burning sun of the tropics being so cold that the hand cannot be held in it without much pain.

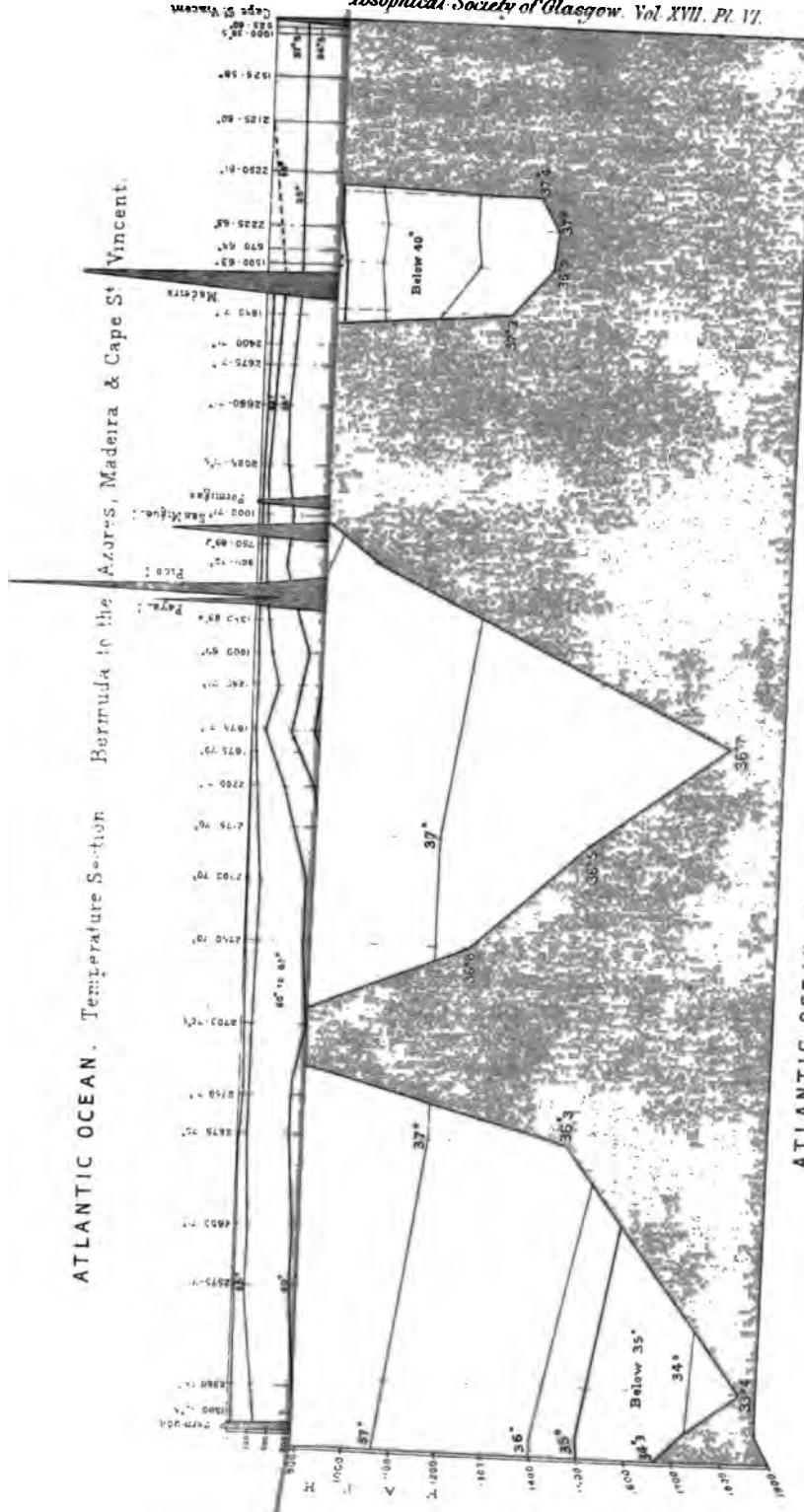
A meridional section down the middle of the Pacific brings out clearly this distribution of temperature, and a similar section in the Atlantic from the Equator to the Tristan Islands illustrates a like distribution of temperature. It will be observed that at the Equator a temperature of 45° is met with at a depth of less than half-a-mile in the open ocean, while at a latitude of 35° South the same temperature exists at a somewhat greater depth. In the North Atlantic the conditions are somewhat different, for there warm water is found at a greater depth than in any of the other oceans; and along the coasts of Europe, from the Straits of Gibraltar to the North of Scotland, water at a temperature of 45° is met with at a depth nearly three times greater than off the equatorial coasts of Africa, and deeper than anywhere else in the open ocean.

The low temperature of the deep water in the ocean is acquired in high latitudes, and chiefly in the high latitudes of the southern hemisphere. The warm salt water of the tropical regions which is driven in relatively rapid currents along the eastern shores of South America, Africa, and Australia by the action of the prevailing winds, on reaching a southern latitude of from 50° to 55° sinks, on becoming cooled, and spreads itself again over the deeper parts of the tropics by a massive slow movement, and at the Equator gradually rises to supply the place of the warm surface currents. This supply from beneath is clearly indicated by the temperatures off the western coasts of Africa and South America in the tropics.

A similar circulation takes place in the North Atlantic, but more modified, as will be presently shown, by the peculiar configuration of the land in the northern hemisphere. The equatorial current which is driven across the Atlantic by the action of the north-east and south-east trade winds is chiefly deflected into the North Atlantic through the configuration of the Brazilian coast of South America. After passing chiefly inside, but partly outside, the West Indies it carries, as the Gulf Stream, a vast amount of heat to the northern regions of the Atlantic. As it passes across the Atlantic to the northern and southern shores of Europe it slowly sinks chiefly on account of the reduction of temperature, and carries heat downwards to a depth unknown along the shores of

ATLANTIC OCEAN. Temperature Section

Barruda to the Azores, Madeira & Cape S^t Vincent.



ATLANTIC OCEAN. Temperature section from Davis Strait to the Shetland Islands.



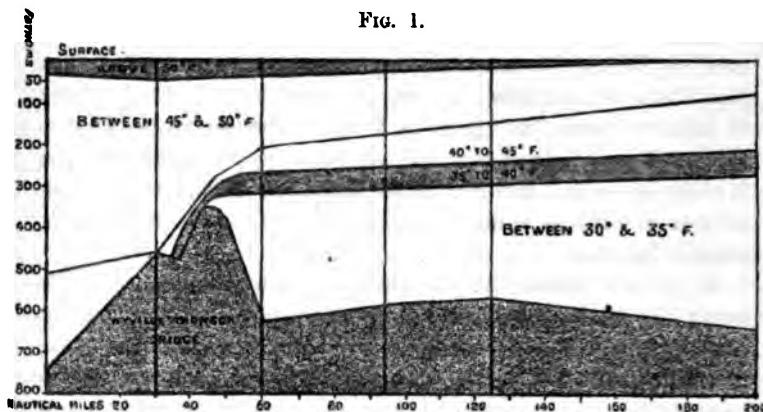
any other continent. This is one of the reasons why a temperature of 45° is met with at a depth of 600 fathoms (about three-quarters of a mile) along our shores; while at the Equator off the west coast of Africa a similar temperature is met with at 200 fathoms. (See Plate VI.) There appears, however, to be another source of this heat along the shores of Western Europe, viz.:—the outflow of a very salt and warm undercurrent of water from the Mediterranean into this part of the Atlantic, which, on account of its greater saltiness sinks and moves northwards in deep water towards Scotland.

In the open ocean the temperature usually decreases with the depth, the coldest water being found at the bottom, but sometimes there are limited areas where the temperature remains the same, from half-a-mile to a mile or even more above the bottom, and in enclosed seas the temperature is usually the same from a few fathoms beneath the surface to the bottom, as in several of the seas of the Malayan Archipelago. It was found in all such cases investigated during the *Challenger* Expedition, that the depth at which the uniform temperature commenced marked the height of a ridge cutting off the enclosed basin from the colder waters of the open ocean at a greater depth—the basin beyond being filled with water at a temperature the same as that found on the top of the ridge. The general result of the *Challenger* researches was to show that no two bodies of water of different temperature could co-exist in contiguous areas on the floor of the ocean, unless separated by a ridge of solid land. There was for some time an instance which was very puzzling, viz., the temperatures which had been recorded by the first investigators of the deep water in the Faroe Channel during the expeditions of the *Porcupine* and *Lightning* in 1869. Here temperatures were found within a few miles of each other, so widely different as 45° and 30° Fahr. at the bottom, and for a depth of over 200 fathoms above the bottom, it being stated that there was no trace of a ridge separating the two bodies of water.

In 1882 I, through the Royal Society, induced the Admiralty to undertake a re-examination of this region, and this was done in H.M.S. *Triton*, under the command of Captain Tizard. An extensive series of soundings showed that a ridge existed right across this Channel, separating the cold from the warm water, the greatest depth on the crest of which did not exceed 310 fathoms. This condition of matters is illustrated in the diagram of the

Channel. (See Fig. 1.) Other soundings have shown that a similar.

FIG. 1.



ridge exists between Faroe and Iceland, and between Iceland and Greenland, so that the North Atlantic is here cut into two basins by a ridge with an average depth beneath the surface of only a little over 200 fathoms. The channel to the northward of this "Wyville-Thomson" ridge is filled up to the top of the ridge with ice-cold water, but none of it appears to pass over into the Atlantic. The cold water at the top of the ridge is met by the stream of warm Atlantic water which flows steadily to the north-east. A mixture thus takes place, and the whole passes on to the coasts of Norway. This warm salt Atlantic water, as it becomes cooled in passing on to Norway, sinks and carries heat down with it, in the same way as we found the Gulf Stream water sink as it approached our own coasts, so that while we find ice-cold water at a depth of 250 fathoms in the Faroe Channel, it is found at a depth of 400 to 600 fathoms off the coasts of Norway.

The track of the warm tropical surface and sub-surface waters of the Gulf Stream can be traced along the bottom from the West Indies across the Atlantic to our coasts and on to Norway, by the dead shells which are strewn upon the ocean bed along their course. In the tropics there are some thirty or forty species of Foraminifera, Pteropods, and calcareous Algae, which live in the surface waters of the ocean, whose dead shells make up frequently from 80 to 90 per cent. of the deposit at the bottom. As the Gulf Stream waters are cooled in passing northwards, many of these organisms die out or become greatly dwarfed in form.

Still, in mid-ocean between this country and Newfoundland, these shells make up 70 to 80 per cent. of the deposit. In the Faroe Channel, where only four or five species are found living on the surface, they make up 30 to 40 per cent. of the deposit south of the "Wyville-Thomson" ridge; and to the north of this ridge, in the central parts of the Norwegian Sea, not much affected by arctic surface currents, they also make up at some places 30 to 40 per cent. of the deposit. The influence of the arctic currents moving from north to south can be traced, in like manner, on the bed of the North Atlantic, especially in the western portion of it, by the presence of glaciated stones and sand, which are carried into low southern latitudes by floating ice from Greenland, Davis Straits, and Labrador. The *Challenger* dredged these stones in north latitude 38°, south of the banks of Newfoundland. The *Talisman* dredged them to the north-east of the Azores in north lat. 44°, and they have frequently been obtained by the telegraph ships in more northern latitudes west of the longitude of 25°—but not east of it.

This cold water from the arctic regions plunges underneath the Gulf Stream off the Banks of Newfoundland, but the ice is frequently carried right into the centre of the Gulf Stream waters, and is occasionally carried far to the eastward before it finally melts and deposits its stones and land debris on the ocean floor. The temperature of the surface water in the North Atlantic must be in some seasons very considerably affected by this ice, and this must have an effect in varying the character of our seasons, and may influence more than is supposed the position of the barometric minima to the east of Greenland in different seasons.

The warm Atlantic water passing over the "Wyville-Thomson" ridge to the north-east sweeps the crest of the ridge with considerable force, varying with the state of the tide. So great is this force that no mud or ooze is deposited on this ridge, and small mineral particles and rock fragments are swept into the deep water to the north-east. On each side of the ridge, in water deeper than 350 fathoms, we have a mud or ooze—that on the south of the ridge containing much more lime and fewer and smaller mineral particles than that to the north of the ridge. These facts may be clearly seen by an inspection of the annexed detailed description of two typical deposits.

On the crest of the ridge the dredge brought up large fragments of glaciated stones, rolled pebbles, and gravel. Mr. B. N. Peach,

who has examined these fragments, finds that to the north end of the ridge they are chiefly identical with the altered old red sandstone, the quartz schists, the diabase dykes, the red-mud stones or flags, the crushed felsites, the granitoids, and gneiss of the Mainland and Islands of Shetland. To the south end of the ridge they resemble principally the Caithness flagstones, the old red sandstones, the Brora oolites, old red conglomerate, ironstone nodules from Jurassic clays, and other rocks from the north, but more largely from the north-east, coasts of Scotland. Mixed up with these are small fragments of chalk and flints. We know of no agencies in this region at the present day which could transport these rocks to the position from which they were dredged, and there can be little doubt that they were carried to this place by the ice which passed round the north of Scotland and over the Shetland Islands during the glacial period. This seems to be corroborated by the fact that among the stones we came across patches of stiff blue clay, which had not the usual character of the muds formed on either side of the ridge. The fine mud and clay has evidently been carried away from the top of the ridge by the action of the currents, and the stones and gravel have thus been allowed to accumulate as the ridge was gradually lowered, for this ridge was most probably once much higher than it now is. It is probable that this ridge has a rocky core which stopped the further movement of the ice to the south in glacial times, and then became covered with moraine materials; indeed, the limit which Dr. Croall gives in his map of the extension of the ice-sheet towards the Atlantic corresponds in a remarkable way with the position of this submarine ridge.

As temperature is the most important factor in the determination of the character of a marine fauna, it might be expected that there would be a considerable difference in the character of the fauna on either side of the "Wyville-Thomson" ridge, and this difference did not fail to strike Carpenter and Thomson in their first exploration of the Channel.

In 1882 I communicated to the Royal Society of Edinburgh the results of some dredgings in the *Knight-Errant*, one in the cold and four in the warm area, at depths greater than 500 fathoms. In the former there were 48 species, and in the latter 71 species, and only two of these were common to the two areas.

I have now collected in this paper some of the results of 15 dredgings in the warm area, and of 19 dredgings in the cold area, in

depths greater than 300 fathoms. These results are far from being final or complete, but as they are exceedingly interesting to geologists and biologists they may, I think, be published without waiting for further additions or corrections. These show (not taking into account the Protozoa, which also differ markedly in the two areas), 217 species from the cold area, and 216 species from the warm area. Of these, 48 species are common to both areas, or one-eighth of the total number of species obtained in all the dredgings. Of the 385 species from these deep dredgings, over 150 belong to new species discovered for the first time during these deep-sea explorations. 96 of the species obtained in these deep dredgings have been recorded from shallower water, that is in depths less than 100 fathoms; 25 of these have been met with in Lamlash Bay, 19 in the Firth of Forth, and the remainder on the Shetland banks and the coasts of Norway.

There have been 205 species of Foraminifera determined from the dredgings on either side of the ridge in depths greater than 300 fathoms. Of these, 164 are from the warm area, 108 from the cold area, and 67 common to the two areas; so that these Protozoans show the same difference as the higher animals. Many of the species common to the two areas are abundant in the one and very rare in the other.

There is not at present sufficient data to speculate with a great chance of success as to the origin of the very different faunas which approach each other on either side of this ridge; but most likely the cold area species will be found more closely related to Arctic forms than those on the warm side, which seem to closely resemble the universally distributed deep-sea forms. One remarkable instance may be stated in illustration of this last remark. In one of the dredgings in 555 fathoms there were over 400 specimens of *Leptomene violacea*, Théel. The only other known specimens of this species were obtained by the *Challenger* in 950 fathoms off the coast of New South Wales, Australia.

If the shallower waters (that is, depths of less than 100 fathoms) about the coasts of North-west Europe be now considered, it will be found that they also are much modified by the influence of warm oceanic currents from southern latitudes, though the contrasts may not be so great as in the Faroe Channel at a depth of three-fourths of a mile. The warm waters which reach the coasts of Norway pass over the shallow banks with a depth of about 100 fathoms, and fill the deep Fjords beyond with water of a tem-

perature higher than the mean winter temperature of the air, or, in some instances, higher even than the mean annual temperature. The temperature of the deep water in these Fjords ranges from $37^{\circ}6$ to $43^{\circ}9$ all the year round, and in depths greater than 100 fathoms is not affected by the cold of winter. The mean winter temperature of the air of these coasts ranges from $16^{\circ}4$ to $37^{\circ}1$, and the mean annual temperature range is from $28^{\circ}7$ to $44^{\circ}5$. So that there seems little doubt that the warm water of these Fjords comes from the Gulf Stream, whose influence, direct and indirect, renders the coast of Norway relatively mild and habitable.

Let us now enquire what effects this warm current produces in the seas round our own coasts. To discover such effects, it is natural, in the first place, to compare the temperature of the surface of the sea on the West of Scotland with the air temperature there. On doing so, it appears that during the six winter months, November to April, while the mean air temperature varies from $40^{\circ}6$ F. at Sandwick, Orkney, to $43^{\circ}3$ F. at the Mull of Cantyre, the mean of the sea temperature varies from $44^{\circ}8$ at Bressay to $46^{\circ}5$ at East Yell, in the Shetlands. The mean air temperature for the winter gets progressively lower as we go north; while that of the sea does not, the latter being $45^{\circ}7$ for Oban, and $46^{\circ}5$ for East Yell, in the Shetlands. These two facts, the considerable excess of the temperature of the sea in winter over that of the air, and the want of variation of that temperature with latitude, point to a disturbing factor, which can only be some warm current that constantly renews the water of our west coasts. This presumption is strengthened when we find the mean winter temperature of the surface above the deepest part of Loch Lomond during this winter to be $42^{\circ}0$, that is, nearly 4° lower than is the case with the sea outside.

If the comparison be extended to the whole year, further confirmation of this view is obtained. The average temperature of the air for the year varies from $45^{\circ}7$ at North Unst (in Shetland) to $48^{\circ}8$ at the Mull of Cantyre, and the average along the whole west coast is about $46^{\circ}1$, thus varying with latitude. The mean annual temperature of the sea, on the other hand, varies from $48^{\circ}1$ at Bressay (in Shetland) to $49^{\circ}3$ at Oban, and the average for the whole coast is $48^{\circ}9$, which is $2^{\circ}8$ above the mean temperature of the air. If any variation of temperature with latitude exists, it is very slight, for we find at East Yell in Shetland the sea surface at an annual mean of $48^{\circ}9$, only $0^{\circ}4$ below the $49^{\circ}3$ of Oban.

These facts can have only one interpretation, and furnish striking evidence of the influence the Gulf Stream exerts on our climate. On the average the sea must heat the air, and not *vice versa*; and the heating effect will be most marked in the coldest months of the year.*

Another comparison, interesting in many ways, adds strength to this conclusion, namely, the behaviour of the North Sea when contrasted with the west coast waters in matter of surface temperature. Briefly put, the facts are these:—The average annual temperature of the surface of the sea, which at Oban is $49^{\circ}3$, is on the east coast of Scotland $47^{\circ}8$; and the annual range from the coldest to the hottest month is only $12^{\circ}1$ on the west, against $16^{\circ}3$ on the east. Again, during March, 1886, the temperature of the open sea near Dunbar varied from $36^{\circ}7$ to $37^{\circ}9$, and further out 39° was observed; while during a trip on the Clyde in the same month $41^{\circ}1$ was the lowest reading, and $43^{\circ}2$ was also obtained. These figures show that the North Sea is much more affected by the land and air than are the lochs of the western coasts. It is out of the direct flow of the Gulf Stream, and is also in connection with the Baltic, which is covered with ice during the colder months of the year, and is therefore at once colder and more variable in temperature; in fact, the sea exceeds the air in mean annual temperature only $0^{\circ}4$ on the east coast, as against $2^{\circ}8$ on the west.

From several points of view, the determination of the temperature of water at various depths, such as 100 fathoms, is more important than the observation of surface temperatures. Unfortunately, the data at our disposal are not numerous enough to allow a comparison between the North Sea and the sea on the west in regard to this, and more observations, especially in winter, are much required. In summer several observations have been taken outside the Mull of Cantyre by my colleague, Mr. J. Y. Buchanan, and the following, observed by him in July, 1882, off Coll in 114 fathoms of water, may be taken as typical of the conditions that obtain at that time of the year:—The surface temperature was $55^{\circ}3$, from that point it gradually fell to $52^{\circ}9$ at 20 fathoms, below which level the temperature was practically uniform, the bottom thermometer registering $52^{\circ}8$. It is probable that the temperature of

* In this comparison, the same places have been referred to in determining both means, namely, those of the air and sea temperatures along the whole coast.

the water at these depths around the Western Islands will change but little during the year, being constantly renewed by the Gulf Stream, and only slightly affected by surface variations of temperature; but this point, of so great interest, remains yet to be determined. In the North Sea observations have not been made at depths exceeding about 40 fathoms. The facts here may be summed up by saying that in summer the bottom water is colder, and in winter warmer, than the surface water, and that the difference is not at any time much more than 1° F.

The physical conditions of the Clyde are very imperfectly known; but at the present time, in conjunction with Mr. J. Y. Buchanan and Messrs. Mill and Morrison, an earnest attempt is being made to add to our knowledge. The lower end of the Firth is, as it were, barred by a submarine ridge, stretching from Sanda at the Mull of Cantyre, across to Ballantrae in the south of Ayrshire. Should the level of the water fall 25 fathoms, the Firth would become a much-branched inland loch. A comparison between the lower part of Loch Fyne and Loch Lomond, in depths of 100 fathoms, is instructive. In March the temperature is practically uniform from surface to bottom in each loch through the whole 100 fathoms, being 41°·1 in Loch Fyne and 39° in Loch Lomond. By the end of June heating has occurred at the surface, but little change has taken place in either basin in the deeper layers. But at the end of August the bottom water in Loch Fyne has risen 7°, being 48°·1, while the water at the bottom of Loch Lomond has remained unchanged. Indeed, the bottom water in Loch Lomond does not appear to change more than 1° from season to season or throughout the year. The rising of the temperature in Loch Fyne appears to be due to mixing, in consequence of the tides, and also by evaporation rendering the salt water of the surface denser, when it consequently sinks. The changes in the fresh-water loch appear to be entirely due to conduction, except that convection currents come into play when the temperature is falling and is low.

Mr. Mill has shown from observations made by the Scottish Marine Station that in the Firth of Forth the temperature conditions differ at various seasons. In winter the temperature is lowest in the river and gradually rises towards the sea, the surface water being at the same time colder than that lying beneath. In summer, on the other hand, the river has a much higher temperature, and the water in the Estuary and Firth becomes progressively cooler as the sea is approached, while the surface water is everywhere

warmer than the lower strata. Twice in the year there is a short period when the temperature of the whole length and depth of the Firth is constant within a fraction of a degree, and these periods mark the transition from winter to summer conditions, and *vice versa*.

The same observer has shown that in the Firths of Forth and Tay the salinity increases from the river to the sea at first very rapidly and afterwards more and more gradually, while the difference in salinity between bottom and surface gets smaller and smaller. When large rivers run directly into the sea, it was found that only the surface water is much freshened, while the tide introduces and withdraws a wedge of salt water in the river bed twice daily.

The importance of extending such observations to the Clyde is very great, and although the Scottish Marine Station is taking every opportunity of doing so, the work must necessarily be slow and not fully satisfactory, unless it is taken up by some workers specially devoted to the Clyde.*

When the marine fauna and flora of the Firth of Clyde is compared with that of the Firth of Forth, it is found to be much richer, both in number of species and generally in luxuriance of growth. While there are no species in the Forth not also found in the Clyde, there are, on the other hand, a considerable number of forms in the Clyde which do not occur in the Forth. At first sight it might seem that the greater variety of the coast lines and the greater depth of the Clyde basins might account for this difference, but when we compare the whole west coast with the east the same contrast holds good. When the whole fauna of the

* Since this paper was read, the steam yacht *Medusa* was engaged from April 13th to 21st, 1886, in examining the temperature of the water in the whole Clyde basin. It was found, speaking generally, that while the surface temperature varied from 42° to 46° with position and weather, the bottom temperature in all the lochs and in the whole Firth down to the bank lying south of Arran lay between 41°·0 and 41°·7, and for the most part was within 0°·1 of 41°·3, and this temperature extended in most cases to within 10 fathoms from the surface. South of the bank, and beyond the Mull of Cantyre, the bottom temperature was 41°·9, and this value was obtained in these positions to within 10 fathoms of the surface. The difference of more than half a degree of temperature on the two sides of this ridge is very significant, indicating that the effect of cooling in winter in the loch basins is sufficient to reduce the temperature of the Atlantic water which enters by this amount. A full discussion of the observed facts cannot be given until observations similar to those just made are repeated at various seasons.

coasts of Britain, the Shetland Islands, and the coasts of Norway is compared with that of the Mediterranean, it is found that over 60 per cent. of the species are common to the two areas. This would seem to suggest that the overflow of water from the Mediterranean and along the coast of Northern Europe may have facilitated the migration of southern species to our shores. However, it is more probable there is an Atlantic shore fauna which has migrated both to the Mediterranean and to the northern shores of Europe which are under the influence of the warm waters of the Gulf Stream. As the cold of the glacial period passed away and the ice retired from the North Sea and Norwegian Sea, the Atlantic fauna and flora gradually invaded the northern shores of Britain and those of Norway, following the track of the Gulf Stream waters. The migration to the North Sea and east coasts of Britain took place round the North of Scotland, and not at all apparently through the English Channel. Some of the west coast species have found their way as far as the Moray Firth, but have not been recorded further south along the east coast. At some points on the east coast and deep pits in the North Sea there are found some five or six species of shells which are not found living on the west coast, but these are found fossil in the glacial clays. These appear to be a remnant of the Arctic fauna which flourished around our coast in glacial times, but which gradually died out or retired with the advent of warmer conditions and the invasion of the Atlantic fauna. If the east coast and the North Sea are poorer in species than the west coast, there is some compensation in the enormous development of the numbers of individuals of many of the species which have been able to establish themselves in the shallower waters of the North Sea, thus largely determining the position of the fishing banks ; for the invertebrates which live on the bottom, and their larvae, which at certain seasons swarm at or near the surface, supply food to the vast shoals of our food fishes. Indeed, we never find great fisheries except where there are relatively shallow banks, such as in the North Sea and the Banks of Newfoundland, where invertebrates flourish at a depth which can be reached by fishes of shallow water. One difference which strikes the naturalist, between these banks situated in northern and temperate latitudes and those situated in the tropics, is that in the latter there is a great development and variety in the number of species, while in the former the species are relatively few and the development of individuals enormous. We still require many more accurate observations of

temperature, specific gravity, and of the distribution of species at different points around our own coasts before many interesting questions as to the fauna and flora and the conditions under which they flourish can be satisfactorily approached. An earnest attempt is being made by the observers in connection with the Scottish Marine Station to collect and arrange the various data, and before long it may be hoped that we shall be in possession of a better knowledge of many of the physical and biological conditions of our coasts.

The facts which have been referred to in this communication establish, however, beyond all question, the presence of water along our shores which has borne with it a large amount of heat acquired in tropical regions, and the effects of this warm water can be traced not only in the estuaries and along the coasts of North Europe, but at a depth of three-fourths of a mile beneath the surface. A very moderate elevation of the "Wyville-Thomson" ridge and the Iceland ridge would cut off this water from the Norwegian Sea and the North Sea, with the result that these seas would soon be covered with ice. On the other hand we might conceive some slight elevations in the northern parts of the American continent which would divert the Arctic water, which now flows into the Atlantic, into the Pacific, with the result that we might have in Greenland a climate as warm as appears to have existed there in Miocene times. The attention which has lately been given to the influence which astronomical phenomena may have in producing great recurring changes of climate appears to have diverted attention from the great effects which may be brought about in extra-tropical regions by small changes in the configuration of continental land, and in the transitional areas, and the consequent changes in the direction of oceanic currents. Yet it is certain that these produce very great effects at the present time, and have as certainly produced as great, if not greater, effects in past times. As a change in the direction of tropical currents brings in its train a change in the position of barometric maxima and minima, and a change in the direction and force of the winds, the configuration of continental land with reference to oceanic currents must be looked upon as the most important terrestrial factor in the production of warm or cold extra-tropical climates.

WARM AREA.

LIST OF ANIMALS OBTAINED FROM THE FOLLOWING FIFTEEN STATIONS
IN THE *Warm Area*.H.M.S. *Lightning*; Station 12—530 fathoms.H.M.S. *Porcupine*; Stations 46—374 fathoms; 47—542; 50—355; 51—440; 89—445; 90—458.H.M.S. *Knight Errant*, Stations 4—555 fathoms; 5—515; 6—530; 7—530.
H.M.S. *Triton*, Stations 2—530 fathoms; 10—516; 11—555; 13—570.

FISHES.

Brama *brosme*, Müll.*Chimæra monstrosa*, L.*Cottus thomsonii*, Gunt.*Haloporphyrus lepidion*, Riss.*Macrurus*, sp. n. (probably young of *M. trachyrhynchus*).

Other 9 species.

MOLLUSCA.

Aclis walleri, Jeff.*Amussium hoskynsi*, Forbes.*Anomia ephippium*, L.*Anomia ephippium*, var. *squamula*.*Aporrhais serresianus*, Mich.*Arca glacialis*, Gray.*Arca nodulosa*, Müller.*Arca pectunculoïdes*, Sc.*Astarte compressa*, Montfort.*Axinus ferruginosus*, Forbes.*Cadulus jeffreysi*, Monterosato.*Capulus hungaricus*, L.*Cardium minimum*, Ph.*Cerithiopsis costulata*, Möller.*Cerithium metula*, Lov.*Chiton arcticus*, G. O. Sars.*Chiton cinereus*, Linné.*Cithna tenella*, Jeff. = *Hela tenella*.*Cocculina corrugata*, Jeff.*Cocculina spinigera*, Jeff.*Columbella costulata*, Cant.*Columbella haliæti*, Jeff.*Crania anomala*, Müller.*Crenella decussata*, Montagu.*Cryptaxis crebripunctatus*, Jeff.*Cyclostrema basistriatum*, Jeff.*Cyclostrema serpuloides*, Mont.*Cylichna alba*, Brown.*Cylichna ovata*, Jeff.

- Dacrydium vitreum*, Tor.
Defrancia formosa, Jeff.
Dentalium capillatum, Jeff.
Dentalium entalis, Linné.
Dentalium striolatum, Stimpson.
Emarginula crassa, J. Sow.
Emarginula fissura, Linné.
Fusus berniciensis, King.
Fusus berniciensis, var. *elegans*, King.
Fusus fenestratus, Turt.
Fusus sarsi, Jeffreys (young).
Ganessa nitidiuscula, Jeff.
Ianthina rotundata, Dillwyn.
Idas argenteus, Jeff.
Leda frigida, Torell.
Leda lucida, Lov.
Leda striolata, Brugnone.
Lima subauriculata, Montagu.
Lima subovata, Jeff.
Lima subovata, var. *augustior*.
Limopsis cristata, Jeff.
Limopsis minuta, Ph.
Lucina borealis, L.
Mactra solida, Linné.
Mactra solida, var. *elliptica*.
Natica affinis, Gmelin.
Natica groenlandica, Beck, var. *contracta*.
Natica montacutii, Forb.
Neæra costellata, Deshayes.
Neæra obesa, Lov.
Neæra striata, Jeff.
Nucula corbuloides, Seguenza.
Nucula tumidula, Malm.
Odostomia electa, Jeff.
Odostomia insculpta, Mont.
Odostomia turrita, Hanley.
Olivia otaviana, Cantraine.
Pecchiolia subquadrata, Jeff.
Pecten groenlandicus, G. B. Sowerby.
Pecten pes-lutrae, Linné.
Pecten sulcatus, Müller.
Pecten vitreus, Chemn.
Pleurotoma exigua, Jeff.
Puncturella noachina, L.
Rissoa soluta, Phil.
Saxicava rugosa, Linné.
Scaphander puncto-striatus, Mig. and A.
Scrobicularia alba, W. Wood.
Scrobicularia prismatica, Montagu.

- Siphodentalium vitreum, M. Sars.
 Terebratula caput-serpentis, Linné.
 Terebratula cranium, Müller.
 Teredo megotara, Hanley.
 Teredo norvegica, Spengl.
 Torellia vestita, Jeff.
 Trichotropis borealis, Brod. and Sow.
 Trochus cinctus, Phil.
 Trochus miliaris, Brocchi (dwarfed).
 Trochus obscurus, Couthouy.
 Trochus ottoi, Ph.
 Trophon carinatus, Jeff.
 Venus casina, Linné.

ECHINOIDEA.

- Calveria hystrix, Wyv. Thom.
 Dorocidaris papillata, A. Ag.
 Echinus (?).
 Echinus elegans, Düb. and Kor.
 Echinus norvegicus, D. and K.
 Phormosoma placenta, Wyv. Thom.
 Phormosoma uranus, Wyv. Thom.
 Porocidaris purpurata, Wyv. Th.
 Spatangus purpureus Leske, (young ?).

OPHIUROIDEA.

- Amphiura bellis, var. tritonis, Hoyle.
 Amphiura filiformis, (O. F. M.).
 Amphiura tenuispina, Ljn.
 Asteronyx lověni.
 Gorgonocephalus eucnemis, M. and T.
 Ophiacantha abyssicola, Sars.
 Ophiacantha bidentata, (Retzius).
 Ophiacantha spectabilis, Sars.
 Ophiactis abyssicola, Sars.
 Ophiactis ballii, Thompson.
 Ophiocten sericeum, Forbes.
 Ophioglypha albida, (Forbes).
 Ophioglypha aurantiaca, VII.
 Ophioglypha signata, VII.
 Ophiopholis aculeata, (O. F. M.).
 Ophioscolex purpureus, D. and K.
 Ophiothrix fragilis, (O. F. M.).

ASTEROIDEA.

- Archaster bifrons, Wyv. Th.
 Astropecten andromeda, Müll. and Tr.
 Cribrella oculata, (Linck), Forbes.

Mimaster tizardi, Sladen.
Pteraster militaris, (O. F. M.).
Zoroaster fulgens, Wyv. Th.

HOLOTHURIOIDEA.

Echinocucumis typica, Sars.
Lætmogone violacea, Théel.
Stichopus (?) tizardi, Théel.
Thyone alticola, Norman.
Thyone raphanus, Düb. and Kor.

CRUSTACEA.

Amathia carpenteri, Norman.
Ampelisca æquicornis, Lillj.
Ampelisca compacta, Norman.
Crangon norvegicus, M. Sars.
Diastylis josephinæ, G. O. Sars.
Diastylis longipes, G. O. Sars.
Dorhynchus thomsoni, Norman.
Ethusa granulatus, Norman.
Eurydice polydendrica, N. and Steb.
Galathea dispersa, Bate.
Geryon tridens, Kröyer.
Haploops setosa, Boeck.
Haploops tubicola, Lillj.
Leptostylis products, Norman.
Munida tenuimana, G.O.S.
Munnopsis typica, M. Sars.
Nephropsis atlantica, Norman.
Ediceros spinicornis, Norman.
Pagurus pubescens, Kröyer.
Pandalus propinquus, G. O. Sars.
Phoxus plumosus, Kröyer.

PYCGONOIDA.

Nymphon grossipes, O. Fabr.
Nymphon longitarse, Kröyer.
Nymphon macronyx, G. O. Sars.
Nymphon macrum, Wilson.
Nymphon robustum, Bell.
Nymphon stroemii, Kröyer.
Pallene malleolata, G. O. S.
Pallenopsis tritonis, Hoek.

ANNELIDA.

Ampharete arctica, Mgn.
Anopla sp.

- Aphrodita aculeata*, L.
Enopla sp.
Evarne johnstoni, M' I.
Hydroides norvegica, Gunn.
Leanira hystricis, Ehlers.
Loetmonice filicornis, Kbg.
Maldane (near) sarsi, Mgn.
Nothria sp.
Protula sp.
Empty muddy and chitinous tubes.

SPONGES.

- Axinella mastophora*, Schmidt.
Dictyocylindrus abyssorum, Carter.
Ecionema compressa, Bwk.
Esperia villosa, Carter.
Geodia nodastrella, Carter.
Hyalonema lusitanicum, Boc.
Hymedesmia johnsoni, Bwk.
Hymeraphia vermiculata, Bk.
Hymeraphia vermiculata, var. *erecta*, Carter.
Phakellia ventilabrum, L.
Pheronema carpenteri, Wyv. Thom.
Plumohalichondria microcionides, Carter.
Reniera fibulata, Sdt.
Stelletta sp.
Tisiphonia agariciformis, Wyv. Thom.

CRINOIDEA.

- Antedon dentata*, Say.
Rhizocrinus lofotensis, M. Sars.

PENNATULIDA.

- Dübenia abyssicola*, var. *smaragdina*, (Kor. and Dan.)
Kophobelemnus mülleri (?), Sars.
Kophobelemnus stelliferum, var. *durum*, (Köll).
Pennatula phosphorea, var. *aculeata*.
Pennatula rosacea.
Pennatula sp.
Umbellula gracilis, Marshall.
Virgularia tuberculata, Marshall.

TUNICATA.

- Ascidia tritonis*, Herdman.
Botrylloides fulgurale, Herd.
Leptoclinum tenuie, Herd.
Molgula carpenteri, Herd.
Polycarpa curta, Herd.

ACTINIARIA.

Actinia sp.

CORALS.

Lophohelia prolifera, Pallas.*Pliobothrus symmetrius*, Pourtalès.*Stephanotrochus magnificus*, Moseley, n. sp.

NUMBER OF SPECIES OBTAINED IN THE WARM AREA.

Actiniaria,	...	...	...	...	...	...	...	...	1
Annelida,	...	...	...	...	...	...	...	...	11
Asteroidea,	...	...	...	...	...	...	...	...	6
Corals,...	...	...	...	...	...	...	...	...	3
Crinoidea,	...	...	...	...	...	...	...	...	2
Crustacea,	...	...	...	...	...	...	...	...	21
Echinoidea,	...	...	...	...	...	...	...	...	9
Fishes,	...	...	...	...	...	...	...	...	14
Holothurioidea,	...	...	...	...	...	...	...	...	5
Mollusca, 88 species and 3 varieties, =	...	...	...	...	...	...	...	...	91
Ophiuroidea,	...	...	...	...	...	...	...	...	17
Pennatulida,	...	...	...	...	...	...	...	...	8
Pycnogonida,	...	...	...	...	...	...	...	...	8
Sponges, 14 species and 1 variety, =	...	...	...	...	...	...	...	...	15
Tunicata,	...	...	...	...	...	...	...	...	5
									216

COLD AREA.

LIST OF ANIMALS OBTAINED FROM THE FOLLOWING NINETEEN STATIONS
IN THE *Cold Area*.

H.M.S. *Lightning*, Stations 6—510 fathoms; 7—500; 8—550; 10—500.
 H.M.S. *Porcupine*, Stations 52—384 fathoms; 54—363; 55—605; 57—
 632; 58—540; 63—317; 64—640; 65—345; 77—560.
 H.M.S. *Knight Errant*, Station 8—540 fathoms.
 H.M.S. *Triton*, Stations 4—327 fathoms; 6—466; 8—640; 9—608;
 12—580.

FISHES.

- Cottunculus microps*, Collett.
Liparis liparis, L.
Lycodes muræna, Collett.
Lycodes pallidus, Collett.
Motella macrophthalmia, Stur.
 Other 12 species.

MOLLUSCA.

- Amussium hoskynsi*, Forbes.
Anomia ephippium, Linné.
Aporrhais serresianus, Michaud.
Arca frielei, Jeff.
Arca nodulosa, Müll.
Arca obliqua, Philippi.
Arca pectunculoïdes, Sc.
Arca pectunculoïdes, var. *septentrionalis*, Sc.
Astarte acuticostata, Jeff.
Astarte sulcata, Da Costa.
Axinus subovatus, Jeff.
Buccinum mörchi, Friele.
Buccinum hydrophanum, Hancock, var.
Cancellaria viridula, Fabr.
Cardium minimum, Philippi.
Cerithiopsis costulata, Möller.
Cerithium metula, Lov.
Cerithium procerum, Jeff.
Chiton albus, Linné.
Chiton arcticus, G. O. Sars.
Chiton mendicarius, Mighels.
Cyprena islandica, Linne.
Dacrydium vitreum, (Holboll), Möll.
Dentalium agile, M. Sars.
Dentalium entalis, Linné.
Fusus berniciensis, King, var. *clegans*.
Fusus concinnus, Jeff.
Fusus delicatus, Jeff.
Fusus hirsutus, Jeff.
Fusus islandicus, Chemnitz.
Fusus lachesis, Mörch.
Fusus sabini, Gray.
Fusus turgidulus, Jeff.
Fusus turritus, M. Sars.
Hydrobia ulvae, Pennant, var. *barlei*.
Laeocochlis granosa, S. Wood.
Leda frigida, Torell.
Leda lucida, Lov.
Leda pustulosa, Jeff.
Leda striolata, Brugnone.
Leda subaequilatera, Jeffreys.
Leda tenuis, Philippi.
Lima sarsi, Lov.
Limopsis aurita, Brocchi.
Limopsis minuta, Philippi.
Mohnia alba, Friele.
Mohnia mohni, Fr.

- Morvillia undata*, Brown.
- Natica affinis*, Gmelin.
- Natica pallida*, Brod. and Sow.
- Neæra cuspidata*, Olivi.
- Neæra lamellosa*, M. Sars.
- Neæra subtorta*, G. O. Sars.
- Nucula delphinodonta*, Michels.
- Nucula tenuis*, Mont.
- Pecten pes-lutæ*, Linné.
- Pecten sulcatus*, Müller.
- Pilidium radiatum*, M. Sars.
- Platydia anomioides*, Sc.
- Pleurotoma scalaroides*, G. O. Sars.
- Pleurotoma scalaroides*, var. = (*Bela scalaris*), G. O. Sars.
- Pleurotoma tenuicostata*, M. Sars.
- Rissoa wyville-thomsoni*, Jeff.
- Saxicava rugosa*, Linné.
- Scalaria greenlandica*, Chem.
- Siphodontalium vitreum*, M. Sars.
- Tellina pusilla*, Philippi.
- Terebratula caput-serpentis*, Linné.
- Terebratula cranium*, Müller.
- Terebratula septata*, Philippi.
- Torellia vestita*, Jeff.
- Turritella terebra*, Linné.
- Venus ovata*, Pennant.

ECHINOIDEA.

- Echinus flemingii*, Ball, var.
- Pourtalesia jeffreysii*, Wyv. Th.
- Spatangus raschi*.
- Toxopneustes drobachiensis*, O. F. M., var.
- Tripylus fragilis*, D. and K.

OPHIUROIDEA.

- Gorgonocephalus eucnemis*, (M. and T.).
- Ophiacantha abyssicola*, Sars.
- Ophiacantha bidentata*, (Retzius).
- Ophiataxis abyssicola*, (Sars).
- Ophiataxis ballii*, (Thompson).
- Ophiobyrsa hystricis*, Lyman.
- Ophiocten sericum*, (Forbes).
- Ophioglypha signata*, Vll.
- Ophioglypha sarsi*, (Lütken).
- Ophiomyxa serpentaria*, Lyman.
- Ophiopholis aculeata*, (O. F. M.).
- Ophiopus arcticus*, Ljung.
- Ophioscolex glacialis*, M. and T.
- Ophioscolex purpureus*, D. and K.

ASTEROIDEA.

- Archaster arcticus*, Sars.
Archaster bifrons, Wyv. Thom.
Archaster vexillifer, Wyv. Thom.
Archaster tenuispinus, Düb. and Kor.
Astrogonium granulare, M. and T.
Briisinga coronata, G. O. Sars.
Briisinga endecacnemosa, Abej.
Hymenaster pellucidus, Wyv. Thom.
Korethraster hispidus, Wyv. Thom.
Pedicellaster typicus, Sars.
Pteraster militaris, (O.F.M.).
Pteraster militaris, var. *prolata*, Sladen.
Pteraster pulvillus, Sars.
Solaster furcifer, D. and K.
Solaster papposus, Forbes, var.

CRUSTACEA.

- Egina spinosissima*, Stimp.
Anonyx lagena, Krüyer.
Arcturus baffinis.
Atylus carinatus, Fabr.
Boreomysis insignis, G. O. Sars.
Boreomysis scyphops, G. O. Sars.
Bythocaris payeri, Heller.
Caprella spinosissima (?), G. O. Sars.
Cleippides quadricuspis, Heller.
Cyclaspis longicaudata, G. O. Sars.
Diastylis josephinae, G. O. Sars.
Diastylis longipes, G. O. Sars.
Eurycope cornuta, G. O. Sars.
Eurycope gigantea, G. O. Sars.
Eusirus cuspidatus, Kröyer.
Haliages elegans, Normau.
Haploops setosa, Boeck.
Hymenodora glacialis, Buchholz.
Icachia granulata, G. O. Sars.
Mera torelli, Goes.
Munnopsis typica, M. Sars.
Oega nasuta, Norman.
Oega tridens, Leach.
Pandalus propinquus, G. O. Sars.
Scalpellum nymphcola, Norman.
Stegocephalus ampulla, Heller.

PYCNOGONIDA.

- Colossendeis angusta*, G. O. Sars.
Colossendeis proboscidea, Sabine.
Nymphon grossipes, Fabr.

- Nymphon macronyx*, G. O. Sars.
Nymphon robustum, Bell.
Nymphon stremii, Kröyer.

ANNELIDA.

- Eunoe equitis*, M'Intosh.
Fascolosoma, sp.
Nemertes, n.sp.
Nephthys longisetosa, (Erst.)
Nothria hyperborea, Hansen.
Thelepus circinatus, Fabr.
Trophonia, n.sp.
Sabella, sp. (fragment).

MEDUSA.

- Atolla borealis*, Haeck.
Lucernaria bathypila, Haeck.

SPONGES.

- Aplysina naevus*, Cart.
Asconema setubalense, Kent.
Chondrocladia virgata, Wyv. Th.
Cladorhiza abyssicola, Sars.
Cladorhiza abyssicola, var. *corticocancellata*, Cart.
Cornulum textile, Cart.
Cribrella hospitalis, Schmidt.
Dictyocylindrus abyssorum, Carter.
Donatia lyncurium.
Dysidea fragilis, Johnst.
Esperia cupressiformis, Carter.
Esperia placoides, Cart.
Geodia nodastrella, Cart.
Halichondria abyssi, Carter.
Halichondria foliata, Bwk.
Halichondria forcipis, Bwk.
Halichondria hyndmani, Bwk.
Hymeraphia vermiculata, Bwk.
Hymeraphia vermiculata, var. *erecta*, Cart.
Hymeraphia verticilata, Bwk.
Latrunculia cratera, Bocage.
Microciona longispiculum, Carter.
Pachastrella abyssi, Sdt.
Pellina, sp.
Phakellia infundibuliformis, Johnst.
Phakellia (Halichondria) ventilabrum, Bwk. (Johnst.).
Polymastia brevis, Bwk.
Reniera, sp.
Rossella velata, Wyv. Th.
Spongia officinalis.
Stylocordyla borealis, Lovén.

SPECIES OBTAINED IN BOTH THE COLD AND WARM AREAS
OF THE FAROE CHANNEL.

MOLLUSCA.

- Amussium hoskynsi*, Forbes.
Anomia ephippium, L.
Aporrhais serresianus, Michaud.
Arca nodulosa, Müller.
Arca pectunculooides, Sc.
Cardium minimum, Philippi.
Cerithiopsis costulata, Möller.
Cerithium metula, Lov.
Chiton arcticus, G. O. Sars.
Dacrydium vitreum, Möll.
Dentalium entalis, L.
Fusus berniciensis, var. *elegans*, King.
Leda frigida, Torell.
Leda lucida, Lovén.
Leda striolata, Brugnone.
Limopsis minuta, Ph.
Natica affinis, Gmelin.
Pecten pes-lutae, L.
Pecten sulcatus, Müller.
Saxicava rugosa, Linné.
Siphodentalium vitreum, M. Sars.
Terebratula caput-serpentis, L.
Terebratula cranium, Müller.
Torellia vestita, Jeffreys.

OPHIUROIDEA.

- Gorgonocephalus eucnemis*, M. and T.
Ophiacantha abyssicola, Sars.
Ophiacantha bidentata, (Retzius).
Ophioactis abyssicola, (Sars).
Ophiocten sericeum, (Forbes).
Ophioglypha signata, Verrill.
Ophioopholis aculeata, (O.F.M.).
Ophioscolex purpureus, D. and K.

CRUSTACEA.

- Diastylis josephinae*, G. O. Sars.
Diastylis longipes, G. O. Sars.
Haploops setosa, Boeck.
Munnopsis typica, M. Sars.
Pandalus propinquus, G. O. Sars.

PYNOGONIDA.

- Nymphon grossipes*, Fabr.
Nymphon macronyx, G. O. Sars.
Nymphon robustum, Bell.
Nymphon strömii, Kröyer.

SPONGES.

- Dictyocylindrus abyssorum*, Carter.
Geodia nodastrella, Carter.
Hymeraphia vermiculata, Bwk.
Hymeraphia vermiculata, var. *erecta*, Carter.
Phakellia ventilabrum, L.
Tisiphonia agariciformis, Wyv. Thom.

PENNATULIDA.

- Kophobelemnus stelliferum*, var. *durum*, (Köll.)

NUMBER OF SPECIES COMMON TO BOTH AREAS.

Crustacea,	...	...	...	...	...	...	...	5
Mollusca,	...	...	...	...	...	...	...	24
Ophiuroidea,	...	...	...	...	...	...	...	8
Pennatulida,	...	...	...	...	...	...	...	1
Pycnogonida,	...	...	...	...	...	...	...	4
Sponges, 5 species and 1 var.,	...	...	...	...	...	...	...	6
Total,	...	...	...	...	...	...	...	48

The following descriptions show the composition of the deposits in the cold and warm area, on either side of the Wyville-Thomson Ridge in the Faroe Channel—

WARM AREA.

Station 10; Lat. $59^{\circ} 40' N.$; Long. $7^{\circ} 21' W.$; 24th August, 1882; bottom temperature, 46° and $46^{\circ} 5$; depth, 516 fathoms.

A grey FORAMINIFEROUS MUD; slightly coherent, homogeneous, finely granular, having a greenish tinge when wet.

I.—*Carbonate of Calcium*, 28·65 per cent., consists of pelagic and other Foraminifera, coccoliths and coccospores, fragments of Gasteropod and Lamellibranch shells, Ostracode shells, spines of Echini, and otoliths of fish. The most abundant Foraminifera are *Globigerina bulloides*; *G. dutertrei*, *G. inflata*, (*G. Orbolina*) *unirecta*.

II.—*Residue after removal of the carbonate of lime*, 71·35 per cent., dark-brown colour; consists of:—

1. *Minerals*, 50 per cent.; mean diameter 0·05 m.m., mostly rounded, consisting of augite, hornblende, magnetite, felspar, mica, olivine, glauconite, fragments of pumice, glauconite casts of Foraminifera.
2. *Siliceous Organisms*, 1 per cent., sponge spicules.
3. *Fine Washings*, 20·35 per cent., consisting of minute undeterminable mineral particles and argillaceous matter.

COLD AREA.

Station 9; Lat. $60^{\circ} 5'$ N.; Long. $6^{\circ} 21'$ W.; 23rd August, 1882; bottom temperature, $30^{\circ} 0'$; depth, 608 fathoms.

A SANDY MUD of a slaty-blue colour, grey when dried; coherent, plastic, and gritty in texture.

I.—*Carbonate of Calcium*, 5 per cent., consists of a few pelagic and other Foraminifera, coccoliths and coccospores.

II.—*Residue* after removal of carbonate of lime, 95 per cent. of a dark-brown colour; consists of—

1. *Minerals*, 80 per cent., mean diameter $0^{\circ} 5$ m.m.; a few fragments reaching 2 mm. in diameter, consisting of fragments of ancient rocks —gneiss, mica schists, quartzites, sandstones, with magnetite, hornblende, felspar, and glassy fragments.
2. *Siliceous Organisms*, 2 per cent., Diatoms and sponge spicules.
3. *Fine Washings*, 13 per cent., argillaceous matter, and fine undeterminable mineral particles.

The above are descriptions of two deposits, the one about twenty miles to the south-east of the ridge, and the other twenty miles to the north-west of the crest of the ridge.

The great difference in the amount of the carbonate of lime, and in the size and number of the mineral particles are worthy of notice.

XXV.—*Hermaphroditic Malformation of the External Genital Organs in the Female, with remarks upon the so-called "Transverse Hermaphroditism."* By JOHN YULE MACKAY, M.D., Senior Demonstrator of Anatomy, University of Glasgow.

[Read before the Society, 12th May, 1886.]

THE appearances about to be detailed were presented by a foetus of about the eighth month of intra-uterine life, kindly put in my possession by Dr. George Dickson. The special abnormality met with is interesting as belonging to a class of malformations which are but rarely seen, viz., the so-called "transverse hermaphroditism," in which the external organs belong more properly to the male sex, while the internal appertain to the female. But the individual case to be described is peculiarly noteworthy on account of its extreme simplicity as compared with others classified under this heading, and standing, as it does, almost half-way between what is usually described as "spurious hermaphroditism" and those complicated cases in which the external organs are entirely male, it affords a very simple explanation of the latter. So far as I have been able to determine, no case showing a similar arrangement of parts has as yet been reported.

The foetus is about 14 inches in length. The skin over the whole body is greatly thickened and is thrown into rough folds and wrinkles. The hands and feet are clubbed, and the fingers are reduced in number to four upon the left side, and on the right side to three.

Examination of the external genital organs shows the following arrangement of parts:—a penis slightly over an inch in length and about half-an-inch in diameter, and behind the penis a longitudinal groove or furrow extending backwards to the anus, which opens into its posterior angle. The penis is perforated at its extremity by a longitudinal slit of $\frac{1}{6}$ of an inch in length. The extremity of the organ or glans is slightly thicker than the rest, but is marked off by no fold of skin corresponding to a prepuce. The skin over the whole organ is rough and thick, similar in this respect to the rest of the cutaneous surface of the body. The groove behind the

penis is marked by two slightly prominent margins, which on being traced forwards are seen to unite with one another and then to be continued still further forwards, forming the under surface of the penis.

The mesial depression which is contained between these margins possesses in its anterior part a depth of about one-eighth of an inch, and is apparently blind, but further back it shallows to the anus. The whole of the inner aspect of this cloacal depression is lined by mucous membrane, while the lips on their outer surface are covered with skin, continuous with that of the general integument.

The external organs of generation, therefore, present appearances which make it extremely difficult to determine the sex. On the one hand, the presence of a penis of moderate size, furnished at its extremity with a vertical slit, apparently continuous with a canal behind, suggests the male. But, on the other hand, the absence of a scrotum, and the presence in its place of a mesial depression, the walls of which are lined with mucous membrane, throw considerable doubt upon the supposition.

The internal organs are entirely female. The ovaries are small, but distinct, and are contained within the folds of the broad ligaments. The Fallopian tubes are short. The uterus is large and triangular in shape, its walls thickest at the sides, where they are directly continuous with the Fallopian tubes. The cervix is very thick, and opens by a large aperture into the vagina. The vagina, in its upper part at least, forms a large canal, with comparatively strong walls. The whole of the inner surface of cervix and vagina is covered with a mucous membrane of an exceedingly rugose description, the transverse folds being specially marked in the cervix and anterior wall of the vagina.

The bladder is a large thick-walled cavity reaching up the whole way to the umbilicus.

Upon examination, the lower end of the vagina appears at first to end blindly, but, on closer inspection, it is found that it is continued downwards as an exceedingly fine canal for about one-eighth of an inch, and opens into the apex of the median depression before described, situated just behind the root of the penis. Through this small canal a fine bristle may easily be passed, so as to demonstrate the continuity of the vagina with the anterior part of the cloacal aperture.

Turning now to the urinary bladder, it is found that, shortly beneath the entrance of the ureters, a well-marked neck is formed

by a dense band of muscular fibres. The aperture of the neck is comparatively a small one, but immediately beyond it the canal of the urethra presents a large dilatation, which extends forwards for nearly one-fourth of an inch. From the anterior extremity of the dilated portion, two distinct canals proceed. The two canals lie in one median vertical plane, the upper one being a male urethra, while the lower opens into a female urinary meatus. They are nearly of similar size at their origin, but as they pass forwards the male passage becomes very much reduced, while the other maintains its size until its termination. Close to its end, however, in the substance of the glans penis, the male urethra again dilates into a very large cavity, similar to that occupying the same position in many monkeys.

The corpora cavernosa are firmly bound to the rami of the pubes, and pass forwards closely united to one another upon the upper surface of a distinct corpus spongiosum. At its anterior extremity the corpus spongiosum forms the glans which, though apparently very large when viewed from the outside, is, upon dissection, seen to consist only of the walls of a large cavity which occupies its substance opening by a vertical slit at the extremity, and receiving the slender urethral canal behind. There is no bulb, but the corpus spongiosum splits behind into two large vascular masses which surround the lower end of the vagina, circumscribing it so closely as almost to occlude it altogether. Between the two lateral parts of the corpus spongiosum a small median portion passes back for some distance, lying between the male urethra and the passage beneath it already described.

The male urethra, taking its origin, as has been already mentioned, from the dilated portion of the common canal, is at first of a size to admit easily a very large bristle. Passing forwards, however, in the substance of the corpus spongiosum, the canal becomes very much reduced, almost indeed to obliteration as a passage, but before it ends in the expanded portion occupying the glans, it is again considerably dilated. The wall of the urethra consisting externally of firm fibrous tissue and internally of mucous membrane, is easily followed. It is so strong that it may be without difficulty separated from the surrounding erectile tissue and entirely dissected out. The mucous membrane is thrown into several longitudinal ridges which are continued forward throughout the whole length of the canal.

The passage to the female meatus courses obliquely downwards

and backwards through the anterior wall of the vagina, which it finally pierces immediately above the narrow constricted portion which has been already described. The canal is more than $\frac{1}{8}$ th of an inch in length, and possesses strong membranous walls. Its diameter is sufficient to allow the passage of a very large bristle. The other organs are of the normal female type.

Looked at from the developmental point of view, the abnormality admits of a simple explanation. The lateral halves of the corpus spongiosum in the male exist as the bulbi vestibuli and partes intermediae in the female. The corpora cavernosa remain similar in both sexes, except in respect of comparative size. The lower vascular portions differ, however, very markedly in their subsequent development. They are originally vascular plexuses, lying upon each side of the genito-urinary cloaca. In the male they unite with one another across the middle line forming the bulb, and they are also projected forwards on the under surface of the penis, forming by their median junction the corpus spongiosum and glans. In the female only the extreme anterior ends of these plexuses unite with one another as glans clitoridis, the succeeding portions atrophy, while the most posterior portions remain ununited on either side of the genito-urinary aperture as the bulbi vestibuli and partes intermediae of Kobelt.

The present case shows an intermediate stage of development, the two vascular masses being partly joined and partly still separate. The anterior ends are united as glans penis, the middle portions, usually atrophied in the female, form here a corpus spongiosum as in the male, while the posterior ends, although separate from one another as in the typical female, are yet brought into such close proximity by the persistence and the junction of the parts in front that they have almost completely shut off from the surface the vaginal portion of the genito-urinary sinus. The anterior portion of the sinus is surrounded and carried forwards as the male urethra, while the posterior portion remains as the nearly obliterated vestibule.

The cases which Simpson* has quoted of "transverse hermaphroditism with the external organs of the male type," and which he has included under the heading of "true hermaphroditism," are very readily explained by comparison with this case. The first,

* Todd's *Encyclopaedia of Anatomy and Physiology*. Vol. ii., p. 684.
Vol. XVII.

a case described by Eschricht,* was that of a child. A well-formed male penis was present. The urethra terminated at its extremity and was of the normal male type. There was a scrotum, but it contained no testicle. The anus was imperforate and the rectum opened into the bladder. There was no vagina; but uterus, Fallopian tubes, and ovaries were present; the uterus being firmly bound to the back of the bladder above the spot at which the rectum entered.

The other case of a similar abnormality is described by Bouillaud.† The subject, a person of the name of Valmont, who had been married as a male, presented a penis of medium size. The urethra opened on the under surface of the glans, but was otherwise normal, containing a verumontanum, and being surrounded by a prostate gland. There were, however, no openings of seminal canals. The scrotum was normal but empty. Internally, ovaries, Fallopian tubes, uterus, and vagina were found, the vagina being much constricted towards its lower end and terminating by a small opening in the membranous portion of the urethra.

In both of these cases the abnormal development is of a similar nature to that already described, but it has been carried to a comparatively greater length. The two lateral portions of the corpus spongiosum have united completely, and have thus formed the under-surface of a penis and male urethra. The first case, that of Eschricht, is additionally complicated by an imperforate anus and the disappearance of the vagina following upon the fistulous opening of the rectum into the urinary bladder. In the second case the union of the lateral masses representing the corpus spongiosum has not been quite complete in front, and the urethra opens on the under-surface of the glans.

On the other hand, Simpson (*loc. cit.*) describes, under the heading of "Spurious Hermaphroditism," cases which have evidently arisen from the same process of mal-development—carried, however, to a less extent. Two of these cases of spurious hermaphroditism are interesting in this connection.

The first of these, described by Beclard,‡ was that of a woman in whom the clitoris was enlarged to $10\frac{1}{2}$ inches. The body of this organ was furnished with a canal, the under surface of which was pierced by numerous small apertures. The labia were small, and the aperture between them was blocked by a dense membrane

* Müller's *Archiv. f. Anat.*, &c., 1836.

† *Journal Hebdom de Med.* Vol. x. ‡ *Bulletins de Faculté*, 1815.

which almost completely closed the cavity, leaving only a small opening. Through this small hole, however, the menstrual fluid and a portion of the urine passed. Urine also escaped by the cribiform apertures in the floor of the canal on the under surface of the clitoris. The other case, reported by Arnaud,* presented a very similar abnormality, but, unfortunately, was not brought to dissection. The clitoris was almost 3 inches long, and showed on its under surface a depression which seemed to underlie the position of a collapsed urethral canal. Towards the posterior end of the organ, however, this canal seemed to be pervious, as it became distended largely during micturition. The orifice from which the urine flowed is said to have occupied its usual position, but the lower end of the vagina was imperforate, and menstruation took place *per rectum*. An opening into the vagina was, however, made by operation, and through this the menstrual fluid afterwards flowed.

In these cases, as in those already described, there has evidently been a junction of the two vascular masses into an imperfect form of corpus spongiosum, so that the case which I have dissected forms a very natural link between them. They all represent merely variations in the extent of abnormal union between two large vascular plexuses. A question now arises as to whether they should be classified under the headings of true or of spurious hermaphroditism. Fortunately the nature of the process renders the answer simple. In true hermaphroditism the genital glands or ducts of opposite sexes are found coexisting in one individual; but in the class of cases under consideration, the malformation is due simply to the abnormal adhesion to one another of vascular masses which are present in both sexes, coupled with a certain amount of hypertrophy. The whole of that class of cases forming what has been called true hermaphroditism of the transverse type, in which the external genital organs are present of the male formation, while the internal are female, should be relegated to the ranks of spurious hermaphroditism.

* *Dissertation sur les Hermaphrodites*, p. 265.

XXVI.—*Genito-urinary Malformations consequent on Pelvic Deformities.* By JOHN YULE MACKAY, M.D., Senior Demonstrator of Anatomy, University of Glasgow. (Plate VII.)

[Read before the Society, 12th May, 1886.]

THE varieties of mal-development which have been described in connection with the genito-urinary organs are very numerous, and in many instances the products of abnormal action are so complex that explanation is difficult, often doubtful. The details of the case about to be described, while interesting in themselves and in respect of their apparent causation, are also noteworthy as presenting, when taken together, a marked approach towards the conditions which accompany the more complicated cases of vesical extroversion. It will be seen that the descriptions which follow are in many respects so similar that they suggest at least that the different cases had a similar origin.

The subject is a female foetus of about the eighth month of intra-uterine development, kindly put in my possession by Dr. Grange of Cumnock. The length of the body from vertex to coccyx is $9\frac{1}{2}$ inches. The upper limbs and upper portion of the trunk are normal, but below the umbilicus many indications of mal-development are met with, the special details of which may be described under the headings of the tissues or systems which they affect.

BONES AND LIGAMENTS.

Both feet are clubbed—the right one particularly so. The right tibia shows an intra-uterine fracture, the end of the upper fragment forming a marked projection underneath the skin as may be seen from the plate. The right and left portions of the symphysis pubis are separated from one another to the extent of $1\frac{1}{4}$ inches, and, in consequence of this, the umbilicus is dragged downwards to a position much lower than usual, lying beneath a line drawn between the anterior superior iliac spines. In consequence, also, the lower limbs are widely everted. There is,

however, no rupture of the skin. A broad tumour over the sacrum owes its presence to a spina bifida which implicates the sacral vertebrae. An abnormal looseness of the sacro-iliac synchondroses gives rise to a slight backward dislocation of the ilia. The anterior surface of the sacrum is slightly convex forwards. The lumbar part of the column presents a curvature towards the right side.

The effect of these alterations in modifying the capacity of the pelvis is very considerable. In a normal foetus with a body length of $10\frac{1}{2}$ inches, 1 inch more than the present specimen, the greatest transverse pelvic diameter at the brim was $1\frac{1}{8}$ inches, and the antero-posterior measurement from the promontory of the sacrum to the symphysis reached $1\frac{1}{2}$ inches. In the present case, the mesial antero-posterior diameter is reduced to $\frac{1}{4}$ -inch; while the transverse measurement, which is less interfered with, marks under 1 inch.

ANTERIOR ABDOMINAL WALL.

The recti muscles arise from the widely-separated pubic bones, and are consequently very far apart from one another below. As they pass upwards, however, they also reach inwards, and after gaining the level of the umbilicus their internal margins are almost in contact. They are somewhat broader than usual. Strong bundles of fibres pass from each pubic spine to the umbilicus, forming two sides of a triangle, the base of which is represented by fibres of similar strength stretched between the portions of the cleft symphysis. The intervening space is filled up by fibres crossing between these bands, not so dense in character nor so regular in disposition. The middle portion of the anterior abdominal wall below the level of the umbilicus is thus closed in by fibres which extend between the widely divergent portions of the linea alba, and which in the normal state are not represented.

INTESTINE.

The duodenum takes an exceedingly sharp curve, the limbs of which lie in very close proximity. The upper descends from the pylorus and passes to the right side; the lower ascends towards the left to its termination, where, opposite the middle line, it is closely bound to the posterior abdominal wall. Owing to the sharpness of the curve, the pancreas is somewhat dislocated from its usual position, and shows as it crosses a marked convexity downwards. Its duct enters the duodenum separately almost half

an inch nearer to the pylorus than the hepatic duct. The jejunum immediately enters the mesentery, the line of attachment of which is directed downwards to the left iliac fossa instead of to the right. There is no part corresponding to the ascending transverse and descending colon, but the ileum expands suddenly into a wide and irregularly-sacculated tube which passes downwards on the left side into the pelvis, the mesentery merging into a loose mesorectum.

Examined closely, the tube into which the ileum passes presents four irregular pouches on its attached or mesenteric border. Beyond the last pouch the lumen of the tube becomes considerably reduced, and the intestine leaves the abdomen to enter the pelvis. The pouches possibly represent nothing more than an irregular dilatation of the least resistant part of the tube following upon the atresia of the anus, to be afterwards noticed. But possibly they may be due to the natural tendencies of growth of suppressed portions, the first representing the caput cæcum, and the others portions of the colon. In relation to this question, it is interesting to note the disposition of the blood-vessels. The ileo-colic artery supplies the lower end of the small intestine and the first diverticulum or pouch. The right colic supplies the second and a portion of the third. The remaining portion of the third and a part of the fourth are supplied by the middle colic artery. The inferior mesenteric completes the supply and furnishes branches also to the first part of the rectum. (The letters *b b* in the Plate represent the dilated portion of the intestine).

It is interesting to note that in spite of the absence of the transverse colon, the great omentum occupies its usual position. Its returning layers are fixed upon the left side to the abdominal wall along the usual line of the meso-colon, and in the middle line to the left surface of the mesentery.

One among a number of otherwise trivial vascular anomalies may be mentioned here—the right hypogastric artery is absent.

GENITO-URINARY ORGANS AND PELVIC VISCERA.

The kidneys are smaller than usual, and their surfaces are smooth and show no lobulation. The right occupies its usual position, but the left is displaced downwards to such an extent that its upper end lies on a level with the lower extremity of its neighbour. The inferior portion of this kidney passes into the

pelvis and is much disorganised evidently from the effects of pressure. The right ureter is, at its upper end, normal, arising from the hilus of the kidney and passing downwards on the inner side of the organ, but the left ureter springs from the dorsal surface of the left kidney and courses downwards upon its outer side. A portion of the left ureter also projects further up than the superior extremity of its kidney in the form of a small rounded sac. Both ureters end in a peculiar manner. They pass downwards underneath respectively the right and left horns of a bicornate uterus, and, turning round the outer margins of the horns, become incorporated with their walls on the anterior surface. In the course downwards from the kidney to the uterus the lumen of each is gradually lost so that the tubes are reduced to solid cords before they sink into the uterine substance. The cords may be traced downwards for some distance along the front of the uteri by dissection into the walls. They will be again alluded to in connection with the vaginæ. (The letter *c* in the Plate is placed upon the right kidney, and the ureter stretches between *c* and *d* to end upon the uterine horn.)

Both ovaries are present. Each is about half-an-inch in length and is rather narrow. It is attached by a fold of peritoneum to the Fallopian tube which lies immediately above it (*e* in the Plate). A firm round ligament connects the ovary with the uterine horn.

Each uterine horn (*d. d.*) is a tubular structure, containing a long narrow cavity. It is distinguished from the Fallopian tube above, and the vagina below, by its greater thickness. The Fallopian tube, uterus, and vagina upon each side, thus form a continuous tube-like structure, the middle portion of which, the uterus, is thickest, and contains a cavity, the upper portion, or Fallopian tube, thinnest and impervious, while the vagina, intermediate in thickness and somewhat flattened from side to side, is separated from the uterus by a marked construction, and is also impervious. A well-marked round ligament upon each side passes from the upper end of the uterine horn through the abdominal wall in the usual way.

The bladder, the lower ends of the two vaginæ, and the lower end of the rectum, are firmly bound together, and form a compact mass situated in the pelvic cavity. They apparently open externally by a single aperture, the position of which is rather further forwards than that which the vulva occupies in normal circumstances. The opening is less than $\frac{1}{2}$ inch in length, and is

surrounded in front and on both sides by prominent folds of skin, which behind merge into the flat margins of a shallow groove, continued backwards between the thighs, to be lost upon the swelling occasioned by the sacral spina bifida.

The anterior wall of the bladder is firmly incorporated with the tissue which has been described as filling up the gap upon the anterior abdominal wall, between the divided portions of the linea alba. The upper portion of the posterior wall is free, but into the lower portion the two vaginæ, which now join with one another, seem to pass directly. To the back of the vaginæ, the rectum is firmly fixed.

When the bladder is laid open by the mesial division of its anterior wall, it is found to contain a cavity which opens widely below. This opening is the entire cloacal aperture before alluded to, which is therefore not subdivided into genital and urinary portions, but passes directly into the bladder. The anterior surface, the fundus, and the upper portion of the posterior surface of the cavity are lined with a whitish membrane, evidently the vesical mucous membrane. This membrane is deficient over the lower portion of the posterior wall, but in front and at the sides it sweeps down to the margin of the cloaca. There is thus left an area in the shape of a horse-shoe upon the base of the bladder, which is left uncovered by the membrane which lines the rest of the interior. Upon examining the uncovered area, it is noticed that it is separated into two portions, an upper and a lower, by an aperture placed between (above and to the left of *f* in the Plate). This aperture is a fistulous communication with the rectum. The portion above it is brownish in colour and soft, the portion below is of a whiter colour and of a firm membranous character, and forms the posterior wall of the cloacal outlet. The impervious vaginæ meet as they reach the back of the bladder. Their more anterior fibres end upon the brown surface above the rectal fistula, while the most posterior fibres descend by the margin of the opening, to form by their junction in the middle line below it the firm whitish area which completes the cloaca behind. The ureters may be traced down upon the anterior vaginal walls for some little distance, but cannot be followed quite to the bladder; their fibres, doubtless, reach the base along with the anterior vaginal fibres just described. The rectum passes down behind the vaginæ where they unite with one another at their lower ends, forming a firm adhesion to their posterior surface, and by means of

a perforation extending through the vaginal tissue its cavity is put into communication with the bladder. Still further down the rectum forms an impervious cord which reaches the skin behind the cloaca.

The cloacal outlet represents, therefore, a genito-urinary aperture only, the position of the impervious anus behind it being marked by the blind termination of the gut. The anterior wall of the opening is urinary, being continuous with the anterior wall of the bladder; while the posterior wall is genital, continuous with the vaginal fibres. There is no subdivision into urinary and genital portions. At the same time, the base of the bladder and the posterior urethral wall are wanting, and the anterior vaginal fibres are not prolonged down to the margins of the outlet.

CAUSATION.

Many of the abnormalities present, both in themselves and in their relations to one another, are easily explained. The talipes, intra-uterine fracture, spina bifida, lumbar curvature, looseness of the synchondrosis, with the consequent displacement backwards of the ilia, and separation of the component parts of the symphysis, are all evidences of an interference with the normal development of the bony and ligamentous tissues of the lower part of the body. Inflammations even of a localised and insignificant nature are known, when they occur in early embryonic life, to produce results by their interference with developing structures quite out of keeping with their apparent character. It is exceedingly possible that the same exalted or inflammatory action at a very early period of intra-uterine life, which gave rise to the spina bifida, affecting the sub-cutaneous or sub-peritoneal tissues and setting up irritation, instituted changes in the lower portion of the body, with the effect of disturbing the relations of the bony and ligamentous parts.*

The condition of the anterior abdominal wall—the linea alba being split into two, the gap bridged by fibrous tissues—seems to be referable to rupture, slowly produced, consequent on the separation of the pubic bones. The position of the bladder as it reaches to the umbilicus is one of close apposition to the abdominal wall,

* The manner in which very slight stimulations or irritations may affect the whole development of the body is dwelt on by Professor Cleland, "Contribution to the Study of Spina Bifida," &c. *Journal of Anatomy*, vol. xvii., p. 257.

and in the case of rupture the anterior vesical wall would naturally fill the gap, forming adhesions with the torn edges. In this way the incorporation of the wall of the bladder with the fibrous tissue which crosses the gap receives a simple explanation. It is possible to imagine that, after adhesion in this manner, the causes to which the original rupture was due might still operate with the effect of destroying the anterior wall of the bladder also, and causing its posterior surface to appear upon the abdominal parieties.

The intestines and genito-urinary organs bear traces rather of the arrest of the normal progress of development than of positive abnormal action, and this arrest is in all probability due to the interference with the growth of the containing cavity and to pressure. The arrangement of the intestine, the bicornate uterus, the double vagina, the small size of the kidneys, and the impervious ureters, are all examples of such a condition. The atresia of the anus is probably due to the pelvic deformity, and to the encroachment of the tumor of the spina bifida. The incorporation of the ureters with the uterine walls is interesting. It is possibly brought about here simply by pressure; but in another case of a fetus affected with genito-urinary abnormality (in which, however, there was no suspicion of undue pressure) I noticed a connection somewhat similar in character, though of less extent, upon the right side. Ruygaard^{*} has described and figured a case in the male in which a posterior Malpighi's canal was in like manner connected with the cavity of a ureter, although their respective cavities did not enter into communication.

The absence of the trigone of the bladder and the posterior wall of the uretra and the non-development downwards to the outlet of the anterior vaginal fibers, giving to the posterior true vesical wall an appearance of being laid bare, and setting the cavity into wide communication with the cloaca, are possibly also evidences of arrested development. But if this be the case, it is impossible to apply our present notions of the development of these parts to the basis of its explanation. Nor, upon the other hand, is it likely that simple fistulae could have produced such a complete fusion of the genito-urinary cavities in their lower parts as is here present. The difficulty seems to me to arise from an erroneous conception of the mode of development of the lower part of the bladder—a subject which, however, I shall leave

* Verslagen te mededeleningen der Kon. Akademie van Wetenschappen-Afdel. Natuur-Kunde. 2 vols. 9th vol. *Acta. Journal d'Academie* 12.

for consideration until the deformities of a similar nature described in allied cases have been briefly noticed.

VESICAL EXTROVERSION.

The peculiar feature in this interesting abnormal condition is the appearance of the posterior wall of the bladder upon the front of the abdomen, this being due to a deficiency alike of the anterior abdominal and vesical walls; but in the great majority of cases this malformation does not stand alone, but is accompanied by others of a more or less important character.

The literature of extroversion is exceedingly large. A succinct account of the main details of the deformity is given by Phillips.* And among the many other more recent contributions is one by Champneys† in which the author, after describing a special dissection, reviews very thoroughly the whole subject, and gives an elaborate list of the writers who have already treated it. Still more modern additions to the literature will be found in the description of special cases by Doran‡ and Ogston.§ The general summary which will be given here is in great part drawn from Champneys' paper, and the references to the descriptions cited will be found in the very complete list of works with which that paper is furnished.

The varieties of the characteristic malformation are very numerous. Mayo describes a case in which there was no fissure either of the abdominal or vesical wall, but only a hernial pouch containing a perfect bladder. The pubic bones were five inches apart. Vrolik describes a case in which a perfect bladder protruded through a fissure of the anterior abdominal wall. On the other hand, the posterior wall of the bladder is not only found projecting upon the surface of body, but cases are described in which the vesical surface is partially or completely split into two lateral portions, the intestine or genital organs lying between the parts. Of such a nature are those described by Bartels, Retzius, Friedlander, Rose, Fränckel, Meckel, and Doran. So far as I have been able to determine, in cases of complete fission it is usually only the lower portion of the normal posterior wall which

* Todd's *Cyclopaed. of Anatomy and Physiology*. Vol. i. Article Bladder.

† St. Bartholomew's Hospital Reports, 1877.

‡ *Journal of Anatomy and Physiology*, 1881.

§ *Journal of Anatomy and Physiology*, 1882.

is present as the divided body, the urinary and generative openings being placed towards the upper extremity of each half. The ureters, when they are not impervious, usually open upon the extroverted surface, in the simpler cases towards the lower end. The vagina, which is very often double, frequently opens immediately beneath it, or between the portions, and even in some very complicated cases upon the vesical surface. The vagina, however, is often quite normal in position.

Champneys' case is very interesting in respect of these openings. The ureters opened separately towards the lower end of the mass, their openings being overhung by prominent wrinkles, suggesting the valvular folds of normal circumstances. Two vaginal openings were placed immediately beneath, overhung in their turn by the projecting lower border of that part of the mass upon which the ureters opened.

The pelvic and abdominal viscera are usually interfered with. The anus often terminates blindly, or there may be fistulous openings into the vagina or upon the anterior abdominal wall, between the lateral parts of the cleft tumour. The ureters are often dilated, sometimes impervious. The kidneys in like manner are frequently affected. The usual arrangement of the intestine is in most cases interfered with, and its peritoneal relations changed. One hypogastric artery is usually atrophied. The penis is frequently split.

There are in almost every case evidences of defects in the bony and ligamentous tissues, particularly those of the pelvis. The symphysis pubis is usually cleft. At one time this was held to be invariable, but sufficient proof has been adduced to show that it is not absolutely constant. Dislocation backwards of the ilia is frequent. Spina bifida is very common; Champneys' and Doran's cases both show examples. It usually affects the sacral or lumbar vertebrae. Curvature of the spinal column is one of the most frequent co-existing deformities. Evidences of similar defects in the bones and ligamentous tissues are usually present in other parts of the body also. Talipes is very frequent, and in connection with the bones of the skull hare-lip and non-closure of the vault have been described.

The theories which have been applied to the explanation of this deformity are exceedingly numerous. Champneys, in his interesting paper, quotes 17 different views, and adds himself one more. It is needless to go into details respecting the many opinions of

the different writers upon the subject. The most interesting are those of Duncan, Velpeau, and Isidore G. St. Hillaire. Duncan regards the deformity as due, in the first place, to an imperforate condition of the urethra. Distention of the bladder follows on account of the accumulation of urine, divarication of the pubic bones and rupture of the abdominal and vesical walls follow in sequence, and thus extroversion is produced. It is hardly necessary to refute this theory. The urethra is not found impervious as a rule, nor does the foetus secrete sufficient urine to distend the bladder to such an extent; and if it did, distension of the bladder is not likely to cause rupture of the abdominal walls.

Velpeau believes it to be due to a process of ulceration from disease, implicating the parieties of the abdomen and bladder. Such a theory does not account for the allied deformities which are so typical of the abnormality. He maintains that the pubic bones are not simply separated but destroyed; but this has not been found to be the case.

Isidore St. Hillaire simply refers it to an arrest of development, and does not attempt to specify the exact manner in which the special anatomical peculiarities are produced. He bases his arguments upon the unmistakable instances of arrested development which invariably accompany the malformation. There is doubtless a general truth in St. Hillaire's theory, but it lacks in detail. Champneys accepts in a general way a theory of arrested development, but seeks to work it out into details, more especially to make it explain the bilateral fission of the extroverted mass which has been noticed as occurring in many cases. According to him the lower abdominal walls have failed to unite from arrest of development. The cleft bladder he explains by regarding the allantois as taking its origin from two lateral portions which subsequently unite to form one vesicle. In this view Champneys follows Bischoff,* who thus assigns a double origin to the urinary bladder.

The explanations offered by Champneys cannot, however, be accepted as satisfactory. The arrest of development is assumed, and no theory of its causation is attempted, nor is anything suggested to explain the very special manner in which the lower abdominal and the vesical walls suffer. In addition, embryologists are now agreed in regarding the allantois as originally a single

* *Entwickelungs-gesch. d. Saugethiere u. d. Menschen,* Leipzig, 1842.

structure, and Bischoff's views have not found confirmation in modern research.

Reviewing the details of the undoubted cases of extroversion, and comparing them with those of the dissection which I have described, it will be noticed that the latter approach the former in many respects very closely. The accompanying malformations in my case are those which are found associated with the most exaggerated forms of extrophy. Further, although the abdominal and vesical walls are not ruptured, they yet present appearances from which it is reasonable to infer that the causes which have operated in producing their abnormal condition would, if prolonged or heightened in their action, have resulted in complete cleavage. Finally, had destruction of the anterior wall of the bladder taken place, the posterior wall would have shown, upon the front of the abdomen, a surface bifid below, the rectum opening by a fistula through the vaginal fibres between the lateral portions. I am inclined, therefore, to assign to extroversion a causation similar to that already detailed—interference with the bony and ligamentous portions of the pelvic walls due possibly to early foetal movements, following upon irritation or inflammatory action, and consequent alterations in the shape and dimensions of the cavity.

The mode in which the rupture of the abdominal wall and the destruction of the anterior wall of the bladder take place, has already been sufficiently indicated, and the effect of the interference with the growth of the pelvis in arresting the development of the organs contained in it has been pointed out. Cases are doubtless described in which extroversion was present unaccompanied by cleavage of the symphysis, but it is possible to imagine causes which would produce great lateral stretching, even with intact articulation.

There remains for consideration still, the method by which the apparent fission of the extroverted mass into two portions is produced. From my dissection it is evident that the bifid appearance of the posterior vesical wall is due to the absence of the trigone and the urethral floor, and in extroversion when fission is present the constant position of the genital or anal apertures between the portions, points to a similar condition. The accepted view,* which ascribes to the whole of the bladder and to the first portion of the urethra, an allantoic origin is

* See *Comparative Embryology*. F. M. Balfour, London, 1881.

unsatisfactory, inasmuch as it does not explain the method by which the ureters are transferred from their original termination on the cloacal end of the gut to the back of the bladder; while the manner in which the urinary and genital ducts are separated from one another at their lower ends is still regarded as an open question.

I am inclined to suggest a hypothesis of the development of the lower end of the bladder somewhat different from the usual one. The cloacal end of the gut is, in a manner not yet accurately known, subdivided into an anterior or genito-urinary portion, and a posterior or intestinal portion, which open separately upon the surface. Into the genito-urinary sinus the allantois ureters and genital ducts open in order from before backwards. Apparently what happens is, that the *tissue between the ureters in front and the genital ducts behind is prolonged down, so as to form a septum, the anterior surface of which persists as the trigone of the bladder and the floor of the first portion of the urethra, while its posterior surface is vaginal.*

Apart from embryological evidence, many things render this probable. Among these are the constant position of the ureters at the upper end of the trigone, the absence of peritoneal cavity between the trigone and the vagina or rectum, and the exceedingly close anatomical connection which subsists between the walls of the lower parts of these organs. Many cases in abnormal anatomy are described, in which ureters or genital ducts opened into cavities other than the usual; and, while some of these are possibly to be explained by fistula, there are others to which that explanation cannot be applied. These can only be understood on the supposition that the septa have developed in an irregular manner.

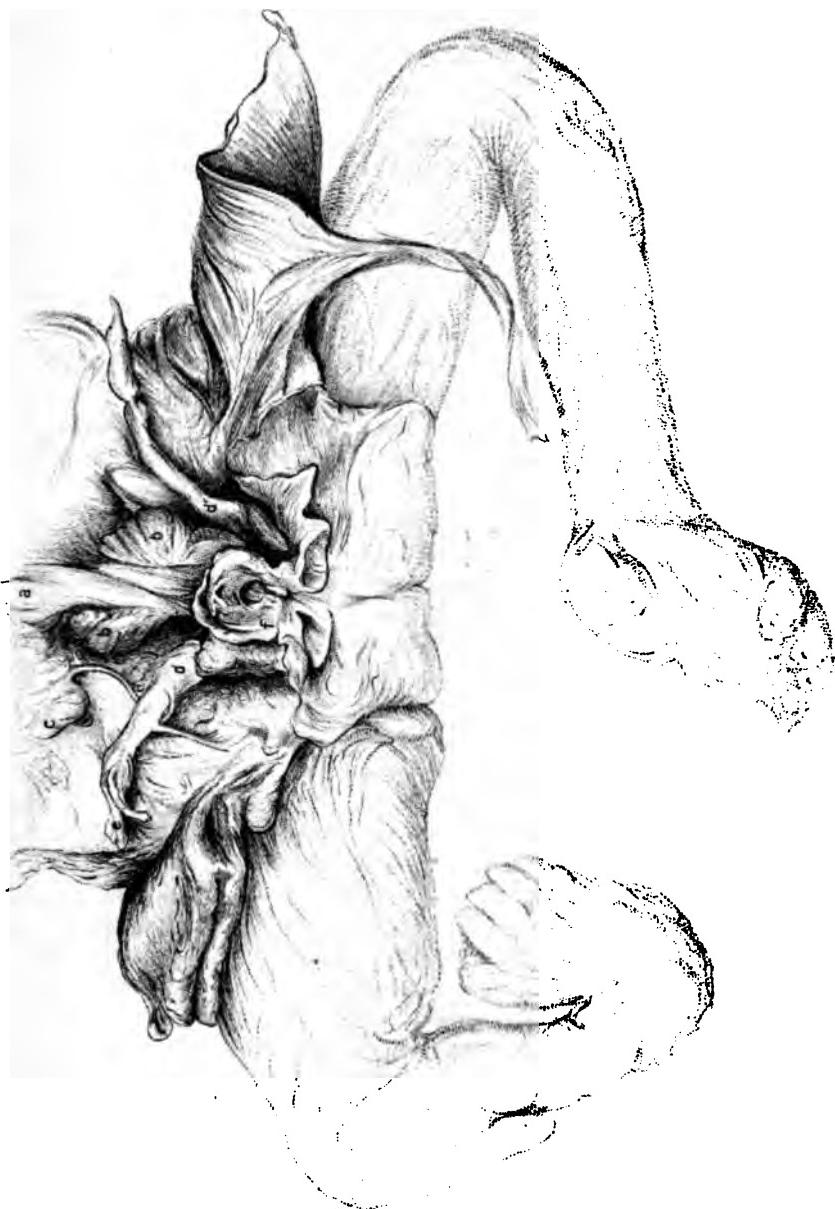
In my dissection, and in those cases of extroversion in which partial fission is found, the suppression of the septum between the genital and urinary portions, and the consequent absence of the base of the bladder and anterior vaginal wall, explain the bifidity of the lower portion of the vesical wall, and refer it to arrest of development, other instances of which are numerous. Complete fission of an extroverted tumour may be explained on the supposition that the upper portion of the posterior wall of the bladder, as well as the anterior wall, has suffered destruction, the protruded mass representing the lower lateral portions, which, in normal circumstances, bound the sides of the trigone.

DESCRIPTION OF PLATE VII.

- a. Small intestine.
- b. Diverticula from large intestine.
- c. Right kidney.
- d. d'. Right and left uterine horns.
- Between c and d' the right ureter.
- e. Right Fallopian tube.
- f. Posterior aspect of bladder.

Above and to the left of f a round aperture indicates a fistulous communication with the rectum.

Above the opening, the limits of the vesical mucous membrane are marked by a horse-shoe shaped edge.





XXVII.—*The Arterial System of the Chamaeleon* (*Chamæleo Vulgaris*). By JOHN YULE MACKAY, M.D., Senior Demonstrator of Anatomy, University of Glasgow.

Read before the Society, 12th May, 1886.

THE ARTERIAL SYSTEM OF THE CHAMÆLEON (*CHAMÆLEO VULGARIS*). Plate VIII.

SHORT accounts of the arterial system in the reptilia generally are given in most of the works on Comparative Anatomy, the most detailed being those of Meckel* and Owen.† But even in these nothing more than a description of the larger vessels is attempted. By far the most important contributions to the study of the vascular system in this group are those of Rathke, and his minute descriptions of the vessels which in their origin are more or less connected with the aortic arches have thrown much light upon the development of the larger trunks. In one of his papers‡ he touches upon the arterial system of the chamaeleon, but it is chiefly to the aortic roots and to the superficial cervical vessels that he directs his attention. In my descriptions which follow, and which have been taken from the careful dissection of three fully-grown specimens of *Chamæleo vulgaris*, much will be found which differs very widely from the accounts of the typical reptilian arteries, more especially in connection with the vessels of the fore and hind limbs, and of the visceral cavity. A complete account of the many modifications of the vascular system met with in this large group of animals would be a valuable aid to the interpretation of much that is still unsolved in the development of this and allied classes.

The trunus arteriosus arising from the heart, divides into four large branches, the pulmonary arteries and the aortæ. After the division all the trunks arch forwards for some distance

* *Traité General D'Anatomie Comparee*, J. F. Meckel. Trad. par H. Schuster. Paris, 1837.

† *Anatomy of Vertebrates*, vol. i.

‡ *Untersuchungen über die Aortenwurzeln und die von ihnen ausgehenden Arterien der Saurier*. Denkschriften der Mathem. naturwissenschaftlichen Classe der Kaiserlichen Akademie. Wien, xiii Band. 1857.

towards the neck, lying close to one another upon the ventral surface of the trachea. Without leaving the thorax, however, they bend upwards and backwards upon the sides of the windpipe, forming arches, the summits of which are placed on the lateral aspects of that organ. Immediately before the height of the arch is reached, each pulmonary artery is connected with the aorta of its own side by a ductus arteriosus and from this point the vessels begin to separate. Accompanied by the pneumogastric nerves, the pulmonary arteries pass backwards along the sides of the bronchi to the lungs. The aortic arches cross the oesophagus, running obliquely upwards and backwards to reach the middle line and meet one another under the column between the fifth and sixth dorsal vertebrae. The left trunk, which is considerably the smaller, gives off no branches. The right arch gives in succession the left carotid, the right carotid, the right subclavian, the left subclavian, and the arteries of the second, third, and fourth intercostal spaces of both sides. The pneumogastric nerves cross the arches ventrally.

ARTERIES OF THE HEAD AND NECK.

The carotids (Fig. 1) are given off very close to one another from the anterior border of the arch very slightly to the right side of the middle line, and, diverging as they proceed, they pass forwards and upwards upon the sides of the trachea for some distance. Leaving the windpipe, they come into contact with the pneumogastric nerve, and are then continued directly forwards in the neck. In this course they are deeply placed, lying dorsally to the muscles which sweep from the hyoid bone to the sternum, and also to the sterno-mastoids. About the middle of the neck a large branch is given off which supplies the tongue, the inferior and lateral parts of the neck, and the shoulder. After this branch is detached the artery is continued almost directly forwards, with a slight inclination upwards, and passes deeply beneath the tympanic bone, and close to the base of the skull terminates by dividing into external and internal carotid trunks.

The common carotid gives but one branch previous to its termination, the *cervico-lingual* (superficial cervical) artery (Fig. 1, c, l.), the origin of which has already been commented upon. The distribution of this vessel has been very carefully studied by Rathke, and my dissections agree very closely with his description. Immediately upon its origin it divides into two, one trunk passing for

wards and inwards on the neck, the other running outwards and backwards towards the shoulder. The anterior division, or *lingual* artery, passing forwards and inwards, escapes from the cover of the sterno-mastoid muscle, and reaching the upper surface of the group of muscles which stretch between the inferior maxillary and hyoid bones, is continued forwards along the upper surface of the base of the tongue towards the extremity of that organ. During this course numerous branches are given off as follows :—(1) A set directed backwards and upwards in the neck, one of the branches sinking deeply, to terminate by inosculating with the ascending cervical branch of the subclavian; (2) branches directed inwards to the trachea and oesophagus, the most anterior of these reaching as far forwards as the back of the palate; (3) twigs ramifying among the muscles which pass between the hyoid bone and the lower jaw, approaching in this area a set of branches from the external carotid artery; (4) terminal divisions in the substance of the tongue. The other portion of the superficial cervical trunk may be named the *scapular*. This artery courses backwards, upwards, and outwards towards the shoulder, crossing underneath the pneumogastric nerve and the great vein of the neck. Close to the shoulder it gives off a branch which ramifies underneath the deltoid muscle, and may be called *suprascapular*. The main trunk then reaches the inner surface of the shoulder girdle, and breaks up into a number of small twigs. A posterior scapular branch runs backwards above the shoulder blade; a sternal branch sweeps forwards along the inner surface of the coracoid bone, and a twig runs inwards along the brachial nerves to anastomose with a slender branch coming outwards from the ascending cervical of the subclavian. These divisions are all very minute, and approach very closely the main trunk of the subclavian artery which here crosses over the first rib.

External Carotid.—From the termination of the common carotid artery the external carotid courses upwards and backwards along the posterior margin of the skull, slightly overlapped by the projecting edge, the convexity of the curve thus made being directed forwards. Reaching the under surface of the temporal bone, the artery passes through a foramen and gains the side of the skull, where it divides into its terminal branches, the occipital and temporo-facial. By means of its branches this artery supplies almost the whole of the outer aspect of the head and also the dorsal muscles of the neck.

Branches of the External Carotid.—(1.) The *submental*, a very slender branch, is directed towards the angle of the jaw, on the inner surface of which it ramifies, running forwards for a short distance, giving slender branches upon both sides. Some of these latter approach very closely the more anterior twigs of the cervico-lingual artery.

(2.) The *inferior maxillary*, a large branch, after leaving the parent trunk, passes to the inner surface of the tympanic bone, along which it descends; reaching, however, the inferior maxillary bone, it changes its direction, and courses along the inner surface of that bone towards the mouth, lying in this portion of its course in a deep groove upon the inner aspect of the bone. About half way forwards the groove conducts the vessel to the inferior margin of the bone, and the artery turns round this to gain the outer aspect, upon which it is still continued forwards towards the middle line. Internal to the tympanic bone two muscular branches are given which are directed forwards. At the posterior extremity of the lower jaw an inferior dental branch is detached and enters the bone. The terminal twigs of the artery ramify upon the under lip, forming part of a circle of anastomosing vessels which surrounds the oral aperture.

(3.) The *transverse facial* is a very slender trunk which runs forwards towards the angle of the mouth, and is soon lost in muscular twigs.

(4.) While the artery is passing through its bony foramen a minute branch is detached, which enters the substance of the bone.

(5.) The *occipital artery*, one of the terminal divisions into which the parent trunk splits, takes its origin upon the outer aspect of the skull, close to the foramen. It passes forwards on the under surface of the projecting portion of the skull to reach the occipital bone. Changing its direction it bends backwards among the dorsal muscles of the neck, and breaks up among them into a large number of branches. The twigs which this vessel gives origin to in its course are all of very minute size, and supply skin and muscles.

(6.) The *temporo-facial*, the largest of all the branches, passes forwards through the temporal muscle to the back of the orbit, there to terminate in two divisions, which enter the posterior portion of a large plexus of vessels surrounding the base of the eyeball. In the course forwards over the lateral part of the skull the branches are not numerous; they extend from both sides of

the vessel into the muscle, and reach the skin. A few reach the outer extremity of the circumoral anastomosis. The orbital plexus will be described after the internal carotid artery.

Internal Carotid.—The internal carotid trunk, very much smaller than the external, bends from its origin forwards and inwards to reach the base of the skull, where it enters a deep bony groove in which it continues its forward course for some distance. At the anterior end of the groove the vessel divides into two, one portion passing upwards through a foramen to reach the base of the brain, the other bending forwards and outwards to join a branch of some size which passes backwards towards it from the orbital plexus. During its course the internal carotid artery supplies upon both sides two or three minute branches, which ramify upon the base of the skull. Upon the brain the artery distributes a large number of branches, some of which pass backwards in the direction of the spinal cord.

ORBITAL PLEXUS.

The orbital plexus is a large collection of arterial vessels which completely surrounds the eyeball, the thickest portion being behind where the terminal divisions of the temporo-facial artery enter it. The plexus receives its blood from them alone, but distributes it to surrounding parts by a number of different channels. One set of efferent branches is directed forwards, and the trunks comprehended in it may be named from their destinations superior labial, superior maxillary, external nasal, and supra-orbital. Branches pass backwards for a short distance on the optic nerve. The largest branch, derived from the orbital plexus, however, is the one which joins the internal carotid artery. This trunk courses downwards, inwards, and backwards, to form the inosculation, giving off secondary twigs from both sides, which are distributed upon the base of the skull. Those which run forward may be divided into anterior palatine and internal nasal trunks, while those which take a backward direction, of less importance, supply the lateral aspects of the cranial base. The junction with the internal carotid is formed after that vessel has given off its cerebral branch and is of a direct character. The connection of the internal carotid artery with the large reservoir of the plexus must have an important influence in maintaining the even constancy of the cerebral circulation. If more blood were being carried by the internal carotid arteries than was

required for the brain, the excess would more readily pass towards the plexus than through the narrow foramen leading into the cranium. On the other hand, if the supply from the internal carotid artery were deficient, blood from the plexus could easily find its way to the brain. In other words, the size of the foramen limits the supply of blood which can go to the brain, while the elasticity of the walls of the rete mirabile maintains the supply so long as the constituent vessels are at all distended.

ARTERIES OF THE FORE LIMBS.

The *subclavian arteries* (Fig. 2), arise in close proximity to one another from the right aortic root. The vessel of the right side passes forwards at once into the space between the first and second ribs, but the other trunk crosses the vertebral column to gain a corresponding position upon the left side. Between the ribs both vessels continue outwards for a short distance, crossing the space obliquely forwards, and finally turn over the borders of the first ribs in company with the lower brachial nerves to become *axillary*. In this course the arteries are placed dorsal to the pneumogastric nerves, and in their first parts at least are to be compared to intercostal vessels.

Branches of the Subclavian Artery.—The first branch of the left subclavian artery belongs to the right side of the body, and will be described after the others. The second branch of the left vessel may be called *ascending cervical*. It arises very close to the commencement of the parent trunk and passes forwards in the neck, running in the line between the muscles underneath the vertebral bodies and those below the transverse processes. Near the base of the skull it turns upwards and terminates by anastomosis with a branch of the cervico-lingual artery already described. Its branches are numerous. The first, a very slender trunk, passes outwards along the nerves of the brachial plexus, and partly supplies the first intercostal space, partly ends in anastomosis with the scapular branch of the cervico-lingual. A set of branches are next given off, the first of which arises in close proximity to the one just described. These vessels pass towards the spinal canal, which they enter between the transverse processes, the most posterior twig passing between the second and third dorsal vertebrae. Before entering they detach very slender branches outwards along the nerves, and afterwards they are

continued on to the ventral aspect of the spinal cord, on which they principally ramify. Very small anastomosing offsets were with difficulty and imperfectly traced, stretching between those small vessels, forwards and backwards, by the sides of the vertebral bodies, after the manner of a vertebral artery. Another set of branches arise from the ascending cervical artery and pass inwards on the under surface of the column, chiefly to supply muscles. Finally, from the outer aspect of the vessel branches take their origin, the distribution of which is similar to that of the terminal twig already alluded to. They end among the dorsal muscles of the neck, in close proximity to branches of the occipital artery.

The *internal mammary* and *internal thoracic* arteries are the next branches of the left subclavian. Both of those vessels take their origin close to the end of the subclavian artery immediately before it becomes axillary. The internal mammary passes backwards by the side of the sternum, and can be traced across four or five intercostal spaces. Very small lateral branches are derived from it and enter the spaces, but owing to the extremely minute size of the vessels the usual anastomoses with intercostals was not seen. The internal thoracic artery, a very slender trunk, could be traced backwards across two or three spaces about the line of junction of the ventral and middle thirds of the ribs. The branches of the right subclavian are similar to those of the left, which have just been described, with the exception that the branch of the ascending cervical which supplies the muscles underneath the vertebral bodies is derived from the vessel of the opposite side.

The *axillary artery* furnishes two sets of branches ramifying respectively upon the anterior and posterior borders of the hollow. In connection with the anterior vessel some circumflex branches arise which course round the upper end of the humerus.

The *brachial artery* passes down the limb running along the inner side of the biceps muscle to reach the elbow. The branches which are derived from this vessel are very slender, they hold mostly a downward course among the muscles toward the joint.

In the hollow of the elbow the artery, still continuing its straight course through the limb, sinks deeply between the bones of the forearm to reach the extensor aspect down which it passes. The main trunk of the lower portion of the fore limb may therefore be termed *posterior interosseous*. This artery is placed at its lower end very deeply, lying between muscles which correspond to the

pronator quadratus and extensores breves pollicis of human anatomy.

The branches are numerous and important. Near the upper end a *medio-ulnar* artery is first given off. This arises from the posterior border of the parent vessel and bends ulnarwards and downwards through the flexor aspect of the limb. Close to its origin small recurrent branches are given; these course backwards towards the joint. Further down the artery divides into two sets of branches. The first, median, running straight down the limb along with the flexor tendons towards the palm, passes underneath the ligament which bends the tendons down, but cannot be traced distinctly into the hand. The second, ulnar, runs along the ulnar border of the limb in the direction of the fifth digit, and lies between the anterior and posterior annular ligaments. It also is of very small size.

The second branch which the posterior interosseous artery furnishes may be called *radial*. It springs from the anterior border of the main trunk and passes almost straight down the limb along the anterior margin of the radius. At its lower end it may be traced to the root of the radial digit in the space between the anterior and posterior annular ligaments. Some branches approach the vessels upon the dorsal surface of the carpus, which are derived from the posterior interosseous, but they cannot be traced into actual anastomosis. Other branches are derived from the posterior interosseous upon the extensor aspect of the limb, but they are small and entirely muscular.

Upon the back of the carpus opposite to the deep cleft which divides the three inner from the two outer digits, the main artery divides into two branches, from which are derived the vessels which supply the fore-foot. Each of the two branches subdivides into two interosseous vessels, and these are continued forwards between the bones to divide again beyond the web into lateral digital trunks. From the interosseous vessels branches are given after the manner of perforating arteries, which sink down between the bones into the palmar aspect. The vessels of the manus are therefore entirely placed upon the dorsal aspect.

AORTA.

After the union of the right and left roots already described, the aorta is continued backwards underneath the vertebral bodies. Opposite the body of the third vertebra beyond that which bears

the last diminutive rib, and immediately in front of that which articulates with the ilia, it splits into three divisions. The central of these is the continuation of the aorta backwards underneath the sacral and caudal vertebrae. The two lateral may be named common iliac arteries. The branches which the aorta furnishes during its course backwards are parietal and visceral.

The *parietal branches* are intercostal and lumbar, and as these vessels, though numerous, are essentially alike in all the main features of their distribution one description will suffice for them all. The first intercostal of either side is derived from the ascending cervical branch of the subclavian artery; it is a very minute vessel. The second, third, and fourth spring separately from the sides of the right aortic root. The succeeding vessels arise in order from the right and left sides of the aorta. Immediately upon their origin the arteries sink between the bodies of the vertebrae and the long muscles which stretch backwards upon their lateral margins. Further outwards they lie in the substance of the intercostal muscles, and they may be traced for a considerable distance between the ribs. In the dorsal portion of each space they course obliquely forwards towards the posterior border of the anterior rib. Their branches are of the usual description. A dorso-spinal passes upwards between the necks of the ribs, an anastomotic stretches forwards above the rib-neck, while collateral branches ramify in the intercostal space. Among the collateral series one is interesting in respect of its course; it passes forwards above the body of the anterior rib to be distributed in the space in front of that to which its parent trunk belongs.

The *visceral* arteries (Fig. 3) are of an exceedingly simple character. From the right root and from the aorta a number of slender straight vessels pass directly to the oesophagus, where they freely ramify, and send on branches, which, on reaching its ventral aspect, pass along the pleuro-peritoneal folds to the pericardium and lungs. Behind the oesophageal branches, three intestinal arteries arise in close proximity to one another. Their place of origin from the aortic stem is opposite the lower end of the stomach, and so close are they to one another here that they are occasionally reduced in number by the confluence of their bases. The distribution of the three separate branches is very peculiar. The trunk intermediate at its origin is, in its distribution, the most anterior of the three. This artery courses through the mesogastrum downwards and forwards to the dorsal edge of the stomach,

along which it is distributed, its fine branches reaching the ventral edge of the viscus and passing forwards towards the oesophageal arteries, and backwards towards the pylorus to anastomose there with another vessel. The vessel the most posterior of the three at its origin, passes directly downwards through the mesentery to supply the median portion of the small intestine, its branches being intercalated upon the tube between the anterior and posterior divisions of the artery next to be described. The last vessel, most anterior at its origin from the aorta, is the largest. This trunk divides into two portions, the anterior of which supplies the pyloric end of the stomach and the duodenal portion of the small intestine, and gives branches which accompany the bile duct through the mesogastrum towards the liver. The posterior division reaches the tube in the neighbourhood of the cæcum, which it supplies with branches. Its terminal twigs reach backwards upon the large intestine nearly to the cloaca. No other intestinal branch arises from the aorta. One or two branches stretch out towards the reproductive glands, and still further back an artery passes on each side to the kidney.

The caudal continuation of the aorta, though comparatively a slender trunk, maintains its size almost to the extremity of the tail. In its course under the caudal vertebræ, it occupies an imperfect canal formed by processes. Its branches are very slender and of the nature of intercostal or intervertebral trunks.

The *common iliac* arteries are short trunks measuring each about one-fourth of an inch in length. They give off no branches, but divide at their terminations into external and internal iliac vessels. The *external iliac*, much the smaller of the two, passes inwards with an inclination backwards along the junction of the abdominal and pelvic walls, and divides into branches as it proceeds. The branches are very slender, and appear to ramify in the abdominal wall after the manner of epigastrics. Some minute twigs seem to be prolonged towards the thigh, but they could not be followed.

The *internal iliac* trunk passes down into the pelvis, running along the lateral wall in company with the sacral and sciatic nerves; and breaks up into a large number of branches. These are visceral and parietal. Two twigs ramify upon the upper portion of the cloaca, and a third sweeps backwards for some little distance to end upon the skin on the margin of the aperture. Of the parietal arteries one has a course similar to that of the human

obturator vessel in its intra-pelvic portion, and another corresponds to a lateral sacral trunk. The continuation of the internal iliac passes into the thigh in company with the large nerves, as a sciatic trunk.

ARTERIES OF THE HIND LIMB.

The *sciatic artery* in the thigh lies deeply between the back of the femur and the hamstring muscles, and is continued straight down into the popliteal space. Its branches are small and numerous, and pass in all directions among the muscles, the greater number of them having a direction forwards, inwards, and downwards. A special branch, larger than any of the others, and accompanied by a large branch of nerve, leaves the main artery close to its upper end and passes forwards and inwards across the posterior aspect of the bone.

The *popliteal trunk* courses straight down through the space, to divide below into anterior and posterior tibial vessels. In its course two branches of some size are furnished. The first of these, muscular in its distribution, passes downwards, running along the margin of the tibia towards the inner side of the ankle, where it is lost among the muscles at the base of the innermost toe. Its terminal branches appear to communicate with the tibial extremity of the dorsal arch. The second branch of the popliteal trunk is articular in its character. It arises as a single vessel which divides into two, the branches circling the bone above the joint and distributing twigs to the interior.

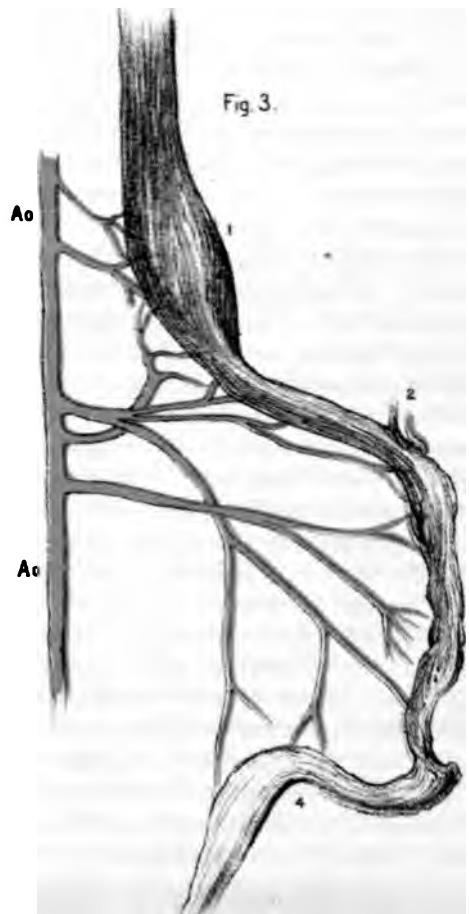
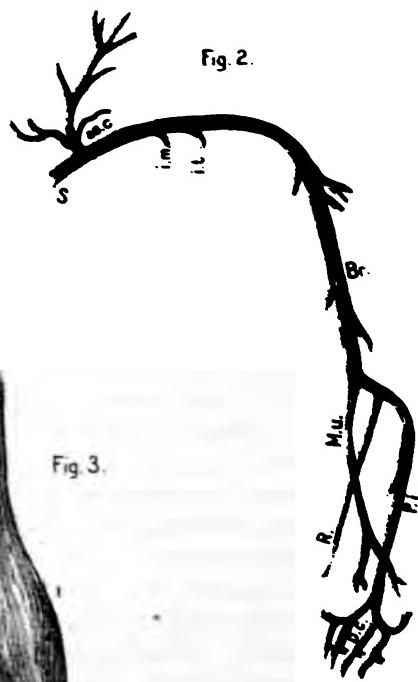
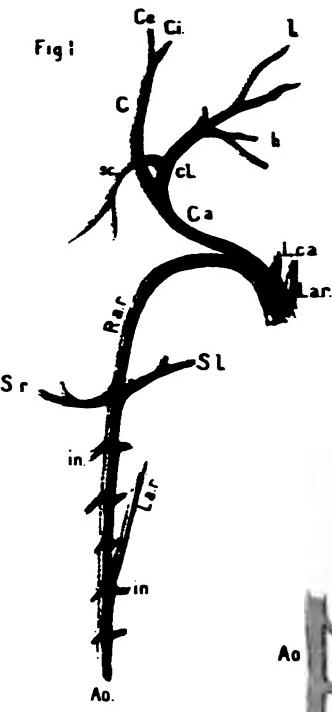
Anterior Tibial Artery.—Of the terminal divisions of the popliteal artery, the anterior tibial is by far the larger. This vessel passes through between the tibia and peroneal bone, and occupies a position in the upper third of the leg close to the anterior surface. As it passes downwards, however, the artery sinks more deeply, and in the lower third the vessel is found between the two bones, lying in front of a muscle corresponding to the pronator quadratus of the anterior limb, and behind a short extensor of the inner toe. Traced still further, the vessel courses behind a strong interosseous ligament, which binds the lower extremities of the bones together in front, and finally it escapes from the cover of this to reach the dorsal surface of the tarsus, upon which it divides. Muscular branches are derived at intervals from the artery during its course. Near the lower

end of the vessel two somewhat larger trunks pass towards the outer and inner borders of the ankle joint. The largest branch, however, is the posterior communicating, a trunk which is given off immediately above the square pronator muscle. Coursing from this position downwards and backwards, the communicating vessel reaches the posterior aspect of the leg close above the ankle joint, where it receives the termination of the posterior tibial artery. After the junction has been effected, the vessel divides into an outer and inner portion, the distribution of which will be followed under the description of the posterior tibial trunk.

The terminal divisions of the anterior tibial artery upon the dorsal surface of the tarsus may be named the *internal* and *external tarsal* arteries. Each of these trunks furnishes two interosseous vessels, which pass onwards between the metatarsal bones to divide at the cleft of the toes into lateral digital arteries. From each interosseous trunk two large perforating branches spring and pass downwards into the plantar aspect of the foot. The extremities of the external and internal tarsal vessels are turned back towards the leg as slender trunks, which pass upwards as if for anastomosis, but the fine branches of these and neighbouring arteries are so small that they cannot be traced into direct continuity.

The *posterior tibial* artery, a long slender trunk, passes down the back of the leg between the superficial and deep muscles. Some muscular branches are given off after which the calibre of the trunk, now much reduced, is restored by the inosculation with the large posterior communicating branch of the anterior tibial artery. Above the ankle joint the vessel breaks up into two branches. The inner of the two branches runs downwards towards the inner side of the joint and approaches closely to the terminations of the long tibial branch of the popliteal artery and the internal tarsal artery. The outer of the two trunks, into which the posterior tibial divides, is traced towards the outer side of the ankle in the direction of the termination of the external tarsal artery; but direct communication was not successfully made out. In its course a minute twig is detached which appears to supply the articulation of the ankle.

No vessels were found coursing along the outer and inner borders of the foot, nor were any seen to enter the plantar aspect from the leg. Here, as in the hand, the vessels of the extremity are placed upon the dorsal surface, the plantar being supplied by perforating branches which sink between the metatarsal bones.



DESCRIPTION OF PLATE VIII.

THE ARTERIAL SYSTEM OF CHAMÆLEO VULGARIS
SCHEMES.

FIG. 1.—ARTERIES OF THE NECK AND THORAX.

- T. a.* Truncus arteriosus.
R. a. r. Right aortic root.
L. a. r. Left aortic root.
C. a. Carotid arch.
L. c. a. Left carotid arch.
C. Carotid artery; *C. e.*, external carotid; *C. i.*, internal carotid.
C. l. Cervico-lingual artery; *Sc.*, scapular branch; *l.*, lingual; *h.*, hyoid.
S. r. Right subclavian artery; *S. l.*, left subclavian.
In. Intercostal arteries.
Ao. Aorta.

FIG. 2.—ARTERIES OF FORE LIMBS.

- S.* Left subclavian.
As. c. Ascending cervical branch.
I. m. Internal mammary.
I. t. Internal thoracic.
Br. Brachial.
P. i. Posterior interosseous.
M. u. Medio-ulnar.
R. Radial.
D. c. Dorso-carpal.

FIG. 3.—ARTERIES OF INTESTINE.

- Ao.* Abdominal aorta.
1. Stomach.
2. Bill duct.
3. Small intestine.
4. Large intestine.

XXVIII.—*The Arteries of the Head and Neck and the rete mirabile of the Porpoise (Phocæna communis).* By JOHN YULE MACKAY, M.D., Senior Demonstrator of Anatomy, University of Glasgow.

[Read before the Society, 12th May, 1886.]

Plate IX.

CETACEAN animals, as a group, present many peculiarities of general structure, the effects of which, as modifying the vascular system, are exceedingly interesting to study. The rudimentary state of development of the limbs and the extreme shortness of the neck have a large influence in altering the usual arrangement of the vessels of the parts which they most affect. In addition, the anatomy of the great arterial rete, possessed by many of them in connection apparently with their power of remaining underneath the water for considerable periods, has lately become the subject of controversy. The descriptions in this paper are taken from the dissection of two specimens (adult and foetal) of the common porpoise, which were put at my disposal through the kindness of Professor Cleland. Short accounts of the anatomy of the larger arteries and of the rete mirabile in the cetacean class are given by Hunter,* and by Owen;† but only a general summary is attempted by either. I need only touch briefly upon those points which have already been sufficiently described.

The first of the primary branches of the aorta, a large innominate artery, divides into two, the brachio-carotid and an artery which Owen, guided by the nomenclature of human anatomy, calls the posterior thoracic, but which is found in the anterior portion of the thorax, coursing backwards as far as the fifth rib. The second of the primary trunks is the left brachio-carotid. The third vessel

* “Observations on the Structure and Economy of Whales.” John Hunter, *Philos. Trans.*, 1787.

† Anatomy of Vertebrates, Vol. III., page 546.

arising from the aortic arch is a comparatively slender trunk which distributes branches to the left side of the oesophagus and to the cervical portion of the left rete. This vessel is not mentioned by Owen in his general description. The last trunk which the aortic arch supplies springs from the descending portion at a considerable distance from any of the others. It is the left posterior thoracic.

The *brachio-carotid* arteries, very short trunks, pass forwards and outwards to terminate by dividing into subclavians which pass outwards, and common carotids which stretch forwards. It is of great importance to notice that the pneumogastric nerves, which in most mammals cross ventral to the subclavian arteries, are placed dorsal to these vessels in the porpoise. The nerve of the left side passes ventral to the arch of the aorta, and sends its recurrent branch forwards upon its dorsal surface, and upon the right side the posterior thoracic artery has relations to the nerve, similar to those of the aorta upon the left. The explanation of this seems to be that the posterior thoracic is the artery corresponding to the usual mammalian subclavian, while the subclavian artery of the porpoise represents the subclavian found in birds, crocodiles, and chelonians, crossing ventral to the pneumogastric nerve, and considered by Sabatier* different from the ordinary subclavian of mammals. It is interesting under these circumstances to note the branches which the two stems, subclavian and posterior thoracic, in the porpoise, give off, in as much as they are both the representatives of vessels which supply the anterior limbs. The distribution of the carotid arteries may, however, first be shortly described.

The *common carotid*, after an exceedingly short course, divides into the external and internal trunks. In the adult specimen the common carotid, though exceedingly short, is still appreciable, but in the foetus the vessel hardly can be said to be present, and the brachio-cephalic trunk divides at its extremity into three arteries, the subclavian, the external carotid, and the internal carotid. No lateral branches arise from the common carotid stem.

The *external carotid* artery holds a straight course forwards and upwards through the neck from its origin to the posterior border of the ramus of the lower jaw. Then bending directly forwards it passes internal to the ramus and is continued towards the

* Observations sur le transformations du Système Aortique dans la Série de Vertébrés. Annal. d. Sc. Nat., 5 Sér., Tom XIX.

under surface of the eyeball. It is better, however, to consider the continuation of the vessel which dips deeply internal to the ramus as a branch, under the name of internal maxillary artery, and to describe as external carotid only that portion of the trunk which intervenes between the origin and the posterior edge of the ramus. The branches of the vessel are numerous. The first to come off upon the right side takes upon the left side its origin, not from the external carotid but from the subclavian. It may be called superficial thyroid. This is a vessel which passes forwards and inwards upon the ventral aspect of the neck close to the skin to be distributed to the trachea and larynx, and to the cutaneous structures underneath. Its most anterior branches stretch forwards for a short distance in front of the hyoid bone. The superficial thyroid artery of the left side, although differing in origin from, is in its distribution quite similar to its neighbour of the right side. The other branches of the external carotid vessels are symmetrical. The next branch may be called superior thyroid, it passes inwards to the parts around the hyoid bone as a very slender trunk. The lingual artery follows. This vessel is of considerable size and courses forwards among the muscles of the tongue to reach the under surface of that organ. A large submaxillary branch runs inwards behind the lower jaw. The last branch which the artery gives before passing into the internal maxillary may be called occipital. This, a very slender vessel, is directed backwards upon the skull and breaks up there into a great number of very minute branches which anastomose with the branches of a much larger occipital trunk derived from the subclavian artery.

The *internal maxillary* trunk, the continuation forwards of the external carotid, is at first deeply placed internal to the ramus of the lower jaw, and is directed thence almost straight forwards to the anterior and outer part of the floor of the orbit. The branches are important. The inferior dental artery leaves the parent trunk under the cover of the ramus, enters a dental canal, and, after coursing through the substance of the bone, escapes near the symphysis by a mental foramen. After the dental artery has been furnished, some muscular branches are given off; these are small and supply the muscles on the deep aspect of the ramus. At the posterior angle of the orbit a temporal artery arises. This rather a small branch, courses upwards upon the skull behind the eye and divides into many straight branches which ramify

over the vertex, anastomosing with the occipital of the sub-clavian behind and with the supra-orbital in front. Underneath the globe of the eye the internal maxillary artery supplies a number of branches which divide upon the orbital muscles and anastomose with twigs coming forwards from an ophthalmic vessel. These may be styled orbital branches. A supra-orbital artery is next given off. This vessel courses upwards along the inner wall of the orbit to a foramen upon the upper border, through which it passes to gain the roof of the skull, where it anastomoses with branches of the temporal behind and the infraorbital in front. From the lower edge of the internal maxillary vessel, while it is still beneath the eyeball, nasal and palatine branches pass off. These vessels, of medium size, descend with an inclination forwards through bony foramina to supply the mucous membrane of the cavities of the nose and palate. A superior dental artery is also furnished to the upper jaw.

After all these branches have been given off the internal maxillary artery is continued forwards as an infraorbital trunk. This vessel passes through a bony foramen on the anterior and under aspect of the orbit, and divides on the fore part of the face into a large number of branches which may be distinguished as labial, facial, and external nasal.

The *internal carotid* artery, in its course through the neck and method of entry into the skull, is similar to the corresponding trunk in the mammalia generally. Its branches are distributed within the cerebro-spinal cavity, but, owing to the absence of the vertebral trunks, their arrangement differs from that which is typically met with. Immediately upon reaching the cranium meningeal branches are detached. These sweep in all directions over the dura mater and are distinguished as anterior, middle, and posterior groups. The posterior set anastomose with a large number of small branches which enter at the foramen magnum, and stretch forwards for some distance upon the basilar portion of the occipital bone. These vessels are derived from the spinal rete. After the meningeal vessels have been given off, a slender ophthalmic artery is continued forwards upon the optic nerve to anastomose in the orbit with orbital branches of the internal maxillary artery.

The arteries which supply the brain are anterior, middle, and posterior cerebrals, and in their distribution upon the surface of the brain they are exactly similar to the corresponding vessels of

human anatomy. The posterior cerebral artery, however, is entirely derived from the internal carotid trunk. In addition, as this vessel sweeps backwards it detaches branches which supply the cerebellum and medulla, and it likewise furnishes an important branch which, piercing the dura mater close to the foramen magnum, enters the canal of the spinal column between the membranes and the bone. Here this branch runs backwards as far as the anterior dorsal region where it is lost. In the course it is deeply placed in the substance of the spinal rete, with which it very freely communicates. By means of this trunk the vessels of the brain are placed in direct communication with the great arterial reservoir which occupies the thorax and extends into the spinal canal.

The *subclavian* artery is at its origin nearly equal in diameter to the external carotid trunk, but rapidly diminishes owing to the number and size of the vessels which it distributes. The artery of the left side gives off as its first branch the superficial thyroid vessel which has already been described. The second branch upon the left and the first upon the right, is a large and important trunk and may be named *cervico-occipital*. This trunk, arising from the anterior border of the subclavian, runs forwards and outwards for a short distance and then divides into two vessels. The posterior of these supplies the superficial parts of the lateral region of the neck in front of and above the fore limb. The anterior branch, of much larger size, courses forwards and upwards until it approaches the back of the skull. Then it turns upwards and backwards and terminates among the dorsal muscles in anastomosis with a large dorsal branch derived from the posterior thoracic. As it is bending backwards behind the skull, it furnishes a large branch which passes directly forwards over the surface of the occipital bone and breaks up into many twigs which anastomose with the occipital and temporal of the external carotid.

From the posterior border of the subclavian the phrenic artery springs. This is a large trunk which rapidly divides into two, an internal mammary portion running backwards upon the ventral wall of the thorax, and a larger phrenic division accompanying the nerve through the cavity. Further out the subclavian furnishes a number of very minute branches, which pass from both sides of the vessel forwards and backwards for a short distance, and supply muscular and cutaneous structures upon

the ventral aspect of the neck and thorax. Still further out, now very much reduced in size, the subclavian divides into brachial and external thoracic branches. The brachial divides into two, which, again dividing, form a number of long slender trunks which run down the fore-limb, supplying it completely. There is therefore to be met with in the limb, not one, but many arterial trunks having a downward course upon it. The external thoracic artery turns backwards upon the lateral wall of the thorax, and breaks up, giving rise to a number of branches.

The small vessel which arises from the arch of the aorta, next in sequence to the left brachio-carotid stem, is represented upon the right side by a branch from the posterior thoracic artery. It may be named *deep thyroid* artery. The vessel runs forwards and inwards for a short distance, sinking dorsalwards as it goes, and breaks up into branches which pass in all different directions. Certain pass inwards, towards the oesophagus upon which they bend backwards for some distance, running upon its outer coat; others pass directly backwards, along with the pneumogastric nerve, and seem to end by supplying the sheaths of vessels and nerves at the anterior outlet of the thorax. Finally, lateral branches stretch outwards in the neck, after the manner of intercostal trunks, giving twigs to the cervical portion of the rete, and piercing into the dorso-lateral muscles.

Posterior Thoracic Arteries.—The difference in the mode of origin of these vessels has been already pointed out, and the presence of a branch from the right trunk, which upon the left side is represented by a vessel from the arch of the aorta, has been noticed. It remains to describe the points which are common to both. They arch forward upon the dorsal wall of the thorax, then crossing the rete they pass outwards, and finally they bend backwards over four intercostal spaces which they supply. The line of their course is along the outer margin of the rete, at the junction of the ventral three-fourths with the dorsal fourth of the costal wall. The branches which they give are of three kinds. The intercostal arteries of the first four spaces sweep round the wall of the thorax to anastomose with the internal mammary below. They are slender vessels. The dorso-cervical or deep cervical trunk, a large branch, is similar in its distribution to the dorsal branch of an intercostal artery. It passes between the neck of the first rib and that of the second to reach the back, and is then continued forwards among the dorsal muscles almost to the base of

the skull, giving branches freely upon its way. At its termination it forms a small rete at the back of the skull, into which enter branches from the subclavian and from the small vessel which springs from the aortic arch upon the left side, and from the first part of the posterior thoracic trunk upon the right. The last set of branches which the posterior thoracic supplies are exceedingly numerous and of small size. They enter the arterial rete.

A comparison of the branches of the posterior thoracic and subclavian arteries with those of the human subclavian trunk is interesting. The vessel in the porpoise which courses dorsal to the pneumogastric nerve supplies branches which are quite similar to those of human anatomy. The higher intercostals and the deep cervicals are beyond doubt, while the trunk, which on the right side springs from this vessel and on the left from the aortic arch, evidently represents the inferior thyroid. From the other trunk the phrenic artery represents the internal mammary. The cervico-occipital artery of the porpoise simulates very closely the distribution of the transverse cervical and supra-scapular arteries in man, with this exception that the most anterior branch is prolonged to the occiput, a peculiarity which may be connected with the extreme shortness of the neck. But the vessel which I have named superficial thyroid in the porpoise, arising indifferently from the subclavian or carotid stem, seems to find no representative in the human subject unless, indeed, the occasional thyroidea ima be held as corresponding. It is interesting, too, to note the very free anastomosis which is found in the dorso-lateral parts of the neck between the branches of the subclavian and posterior thoracic trunks.

THE RETE MIRABILE.

Upon the dorsal wall of the thorax, occupying its inner fourth, a large mass of convoluted arteries is to be found spread out as a continuous sheet beneath the pleura.

This rete has received a detailed description from Breschet* and on account of its recognised importance has attracted much attention. Hunter† in 1787 briefly noticed it in the piked whale, and a description is given by Owen‡ of its characters in the porpoise. Of late years, however, an exceedingly interesting account of this

* *Hist. Anat. et Phys. d'un organe de nat. Vasculaire découvert dans Cétacés.* Breschet. Paris, 1836.

† *Loc. cit.*

‡ *Loc. cit.*

rete, as found in the narwhal, has been furnished by Dr. Season Wilson,* and his detailed descriptions throw so much doubt upon the facts of previous observation that further examination is warranted. My dissections in the foetal porpoise, while they show a state of parts differing very materially from that described by Prof. Owen and earlier observers, yet do not entirely coincide with what has been seen by Dr. Wilson in the narwhal, and it is therefore probable that the anatomy of the rete is not quite the same in all classes of Cetaceans.

Occupying a position on both sides of the vertebral column as above stated, the vascular mass extends forwards for a short distance into the neck. Its posterior limit is marked, upon the right side, by the eleventh dorsal vertebra, while upon the left the extent to which it passes backwards is less by about half an intercostal space. Towards their posterior portions the plexuses of the right and left side are united across the middle line dorsal to the aorta, but in front they are widely separate. The arteries which supply the rete are chiefly the posterior thoracics and the first six aortic intercostals, but branches enter the anterior extremity of each plexus from the inferior thyroid trunk. Close to the roots of the intercostal arteries small vessels also spring directly from the aorta to enter the plexus. Observers differ as to the behaviour of the intercostal trunks. Hunter and Owen speak as if these vessels, upon entering the rete, became coiled up in a manner similar to that in which the spermatic artery is found in the bull; Breschet describes these vessels as if they broke up on entering the rete, and were reformed upon passing out into the intercostal spaces beyond; and Wilson finds in the narwhal that certain of the intercostals are lost entirely in the plexus, and that others, after giving off many branches to it, make their appearance at its outer border, though much reduced in size. In the foetal porpoise I found all the intercostal arteries passing through the substance of the rete into the spaces beyond, and traced their terminal ramifications to anastomosis with the internal mammary arteries. They are neither convoluted nor coiled, but hold a straight course outwards, surrounded on all sides in the first part of their way by the vessels of the plexus. The rete is formed by long slender vessels which arise from the intercostal trunks, or directly from the aorta; but, although each intercostal artery

* *Journal of Anatomy*, 14. 1880.

gives off a very large number of such vessels as it is passing through the plexus, its own calibre is at first but little reduced. At the outer border of the rete, however, each intercostal artery sends off a large dorso-spinal branch which passes upwards, accompanied by a deep off-set of the plexus, and after parting with this vessel the intercostal trunk becomes very materially lessened in diameter. Traced still further outwards, it gives rise to two long slender vessels which sweep round the wall of the thorax, between the intercostal muscles. The great diminution in size of the intercostal artery after it has passed through the plexus seems to me important in connection with the physiology of the rete.

The constituent vessels of the plexus are also the subject of considerable difference of opinion. Owen remarks that each individual artery is coiled and may be unravelled for a long distance without lateral branches being found. Wilson, on the other hand, finds a freely-branched network, and characterises it as anastomotic. He subdivides the constituent vessels, from their comparative size, into three sets which he names, *vasa maxima*, *vasa media*, and *vasa minima*. He also describes puckerings upon the walls of some of the vessels. In the porpoise the arteries which enter the rete are nearly all of similar calibre, and though they divide freely the resulting vessels retain very closely the diameter of the parent trunk. Followed from its origin from an aortic intercostal, one of these arteries may be seen to become tortuous as it enters the rete; shortly afterwards it divides, and the arteries which it gives rise to soon divide again. Every here and there upon the course of a tortuous vessel a complicated knot is formed. The knot usually lies in the fork of a division, and one or both of the arteries may take part in it, the vessels being apparently looped and twisted round one another. Any vessel may be traced from one intercostal artery through one or more of such knots to end finally in another intercostal trunk, the same size being maintained through the whole course, spite of repeated divisions. There is thus therefore a perfect inosculation of large numbers of vessels. So far, I have spoken as if the vessels were all of one calibre. Another set of vessels is to be found, however, the arteries belonging to this class being much smaller in size than the others. They seem to be of a transverse or connecting nature, and pass from one to another of the larger vessels. They are usually short straight trunks, but they may run for a

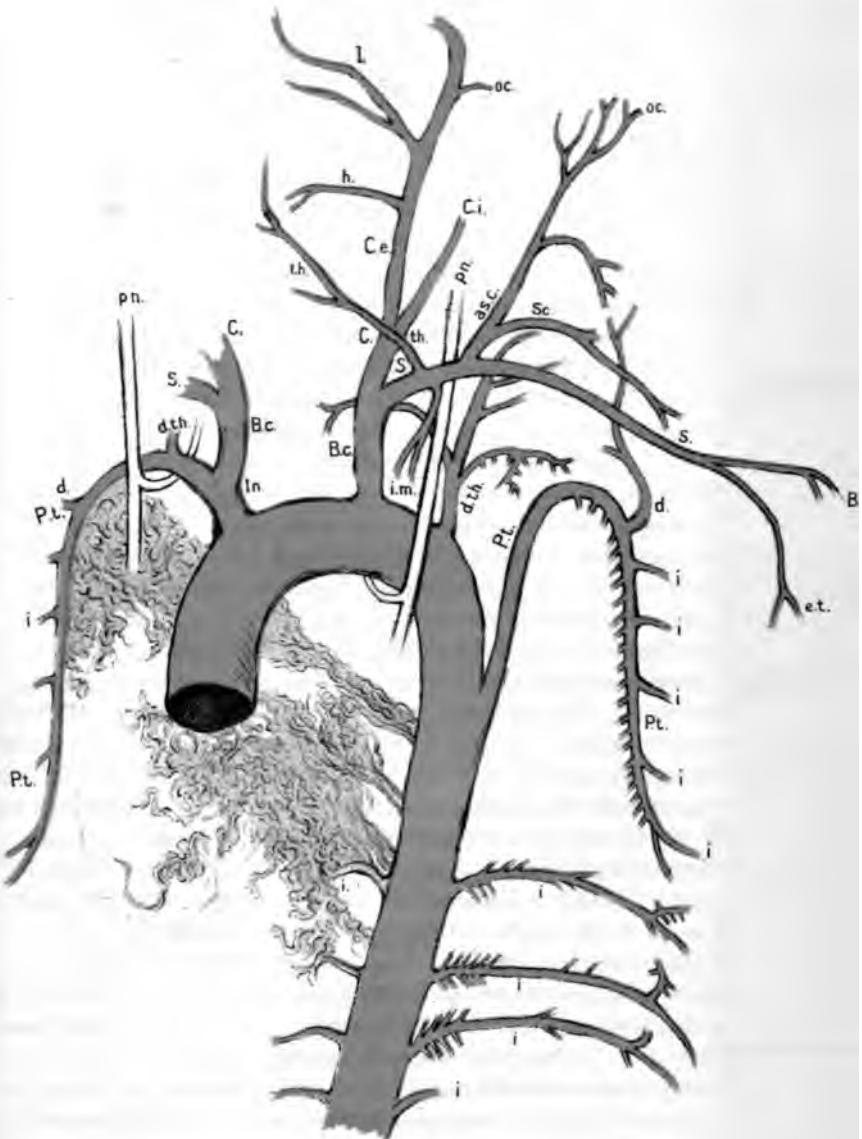
considerable distance and in that case they are often slightly tortuous and are branched. I have not been able to find the three kinds of vessels which Dr. Wilson has seen in the narwhal, nor have I noticed any of the puckerings in the walls which he speaks of.

The thoracic rete sends off, opposite each intervertebral foramen, a deep projection into the spinal canal, and a large rete is formed there between the dura mater and the bone. The spinal plexus is largest in the neck where it receives branches from the deep cervical artery. It ceases behind in the posterior dorsal region. Imbedded in the upper part are two vessels which have been described as connected with the posterior cerebral artery.

The generally accepted explanation of the use of these great retia is that they act as stores for oxygenated blood which is brought into use while the animal remains for a long time underneath the water. Pressure of the lungs due to engorgement with venous blood and inflation with air, would doubtless tend to drive the blood from the reservoirs into the circulation. The spinal cord supplied by a rete, in direct continuation with the thoracic plexus, would thus receive pure blood, while the brain, if little were coming to it in the usual way, would get its supply through the posterior cerebral artery from the spinal rete. The posterior thoracic arteries too would carry pure blood back towards the bases of the large trunks which supply the anterior extremity of the body, by which vessels, mixed with what venous blood was coming to the left heart from the lungs, it might be distributed. The small size of the intercostals beyond the rete renders it very unlikely that through them the blood of the plexus reaches the circulation; but on the other hand, the large diameter of the bases of these trunks makes it probable that blood will pass from the rete back into the aorta. If, as I have suggested, such be the case, the pure blood of the rete will reach the great muscles of the tail, mixed, however, with venous blood entering the descending aorta through the patent ductus arteriosus, and also, perhaps, by way of the pulmonary veins through the heart.

DESCRIPTION OF PLATE IX.

SCHEME OF THE ARTERIES OF THE NECK AND
THORAX OF THE PORPOISE.*In.* Innominate artery.*B. c.* Brachio carotid.*C.*, Carotid; *C. e.*, external carotid; *C. i.*, internal carotid.*h.*, hyoid; *l.*, lingual; *oc.*, occipital.*S.*, Subclavian artery; *th.*, superficial thyroid branch; *as. c.*, ascending cervical; *sc.*, scapular; *oc.*, occipital; *e. t.*, external thoracic; *i. m.*, phrenic and internal mammary.*Br.* Brachial.*d. th.* Deep thyroid artery.*P. t.* Posterior thoracic; *d.*, its dorsal branch.*i. i.* Intercostal arteries.On the right side a portion of the thoracic rete is shown.
pn. Pneumogastric nerve.



Mr. TOLKE on the Morphology of the Cervical Vertebrae. Part 5th

——In the Morphology of the Cervical Vertebrae. Part 5th
and on a Lateossifying Elevation of the Axis. By J.
Ernest Young, M.A., M.B., C.M., Demonstrator of Anatomy,
University of Glasgow. Plate X.

Read before the Society, 12th May, 1886.

My attention was drawn to the specimen figured in the Plate by the fact that the ordinarily described roughnesses which mark the upper pillars supporting the articular surfaces of the cervical vertebrae had here been more or less distinct processes. These processes are seen to form the continuation upwards and inwards of rough markings which are situated on the back of the articular pillars and are most distinct on the right and left sides of the sixth cervical vertebra and on the left side of the fifth (Plate X., a). They lie behind and below the upper articular surfaces of their respective vertebrae, those on the left side in the fifth and sixth measuring one-eighth of an inch, that on the right side of the sixth somewhat less. On the right side of the fifth vertebra a mere nodule, slightly raised from the surface, affords a trace of the processes found in the others, while on the seventh, owing to the obliteration of the lateral notch, which in the upper cervicals lies between the articular pillar and the transverse process, the raised marking from which the projection springs is seen (specially on the left side) to pass out on to the back of the transverse process, only a trace of roughness being left behind the articular process. From behind the articular processes in the first dorsal all traces of the projections have disappeared, and on the left side a slight elevation about half way out on the transverse process is all that marks the continuation downwards of the series (Plate X., b).

With reference to those processes, I examined the cervical vertebrae in thirty-seven cases, and found that in one case the series of distinct though small processes, similar in form and position to those in the specimen figured, was complete on both

sides, in the fourth, fifth, and sixth vertebrae. In eight other sets one or more of such projections was present, the series being in these cases interrupted. In the remaining instances the articular pillars, as a rule, presented only the usual more or less well-marked roughness, though indications of the processes in question were present in some. In all the specimens in which the processes were noted they were seen to be confined to the lower of the cervical vertebrae—none being found higher than the fourth. In some instances the change in position of the roughness towards the transverse process is not indicated, as it is in the case figured, in the seventh cervical, and the roughnesses are still altogether confined to the articular pillars of that vertebra.

The occasional occurrence, then, on the cervical articular pillars, of distinct projections, developing in connection with the roughnesses which usually exist there, gives a significance to those otherwise unimportant-looking markings, and seems to point to the presence of an element not generally recognised in the cervical vertebrae.

In order to avoid ambiguity, it may be well at this point to indicate the exact meaning which is attached to certain terms used in the following pages. Retzius (*Müller's Archiv*, 1849, p. 685) distinguished three elements—costal, mammillary, and accessory—in the dorsal and lumbar transverse processes. The costal element is the rib-bearing part. The mammillary and accessory elements affording points for muscular attachment he called "muscle" processes. Cleland (*Nat. Hist. Review*, 1863) has shown that the costal element, forming part of the primary costal arch embracing the visceral cavity, has a very different morphological value from that which can be attached to processes projecting out into the muscular mass. His view makes clear the distinction between costal and "muscle" processes, and constrains us to look on the dorsal transverse as a compound process in which vertebral processes of essentially different characters have been united. The costal process we may call the true or primary transverse process, the mammillary and accessory we may distinguish as secondary processes, and thus prevent misunderstanding.

These roughnesses and occasional processes above described are, then, the continuation in the cervical region of the series of secondary processes which Retzius traced in the lumbar and dorsal vertebrae. In the thorax the secondary processes and the rib-bearing process are united in the transverse process; but here

again, in the cervical region, as in the lumbar, they are to a certain extent separated from one another. The serial homology of these parts in the cervical vertebrae in the human subject has, I find, been recognised by Aeby (*Lehrbuch der Anat.*, p. 139) and by Henle (*Anat. des Menschen*, p. 30) among foreign anatomists, but neither of these writers goes into any detail on the subject. Retzius (*op. cit.*, p. 653) points out the existence of mammillary processes in the cervical vertebrae of *Myrmecophaga tamandua*, but makes no mention of their occurrence in the human subject. Among English writers, Owen (*Comp. Anat. of Vertebrates*, vol. ii., p. 397) describes the five posterior cervical vertebrae of *Myrmecophaga jubata* as possessing "a metapophysial tubercle on the outer side of the prozygapophysis;" while in *Quain's Anatomy* (7th edition, vol. i., p. 22) allusion is made to the continuation of the series of the mammillary processes in the prominences on the articular processes of the hedgehog and of the armadillo. The only other English work consulted that refers to the existence of these processes in the cervical region is Humphry's *Treatise on the Human Skeleton*, in which, at p. 142, it is stated that "in the neck, faint indications of the upper and lower tubercles" (mammillary and accessory tubercles) "may be detected in the form of slight projections at the extremities of the posterior transverse processes."

The probability of the existence of secondary processes in the cervical, homologous with those in the dorsal and lumbar regions, is strengthened by the occurrence of such processes in the cervical vertebrae in some of the lower animals. Mammillary processes are found (*vide supra*) in two of the ant-eaters, in the hedgehog, and in the armadillo. In the beaver and the tiger these processes are also present. In the tiger, where throughout the vertebral column the series of secondary processes is strongly developed, and can be easily traced as far forwards as the fifth cervical, the homology of the processes behind the articular pillars in the fifth, sixth, and seventh cervicals is all the more plainly indicated by the secondary process in the first dorsal lying, not on the transverse process, but behind the portion of the bone bearing the articular surfaces.

Observation of the form of the cervical vertebrae in the human foetus reveals the existence of a stage in development in which the portion of the vertebra supporting the superior articular surface bears a much closer relation than it does in the adult to the true transverse process. For, as we pass from older to younger foetal specimens, the lateral notches between the articular pillars and the

transverse processes gradually become less, till, as in the seventh cervical in the adult, the superior articular surface lies on the root of the transverse process. Further, in the cervical vertebrae of a foetus, measuring about three inches from vertex to coccyx, the lateral ossification indicating the root of the transverse process passes into the projecting mass which bears the upper articular surface, and which is intimately associated with the partly cartilaginous portion, afterwards to become the free transverse process in the adult. These facts of development, when taken along with the existence in the adult of the solid pillars, bearing the cervical articular surfaces, which, even in the adult, are only partially separated from the true transverse processes, and have much more the character of lateral projections from than of simple thickenings of portions of the vertebral arch, seem to indicate that these cervical articular pillars take origin in connection with the true transverse processes, and that therefore the articular surfaces, at least the superior ones, rest on the roots of these processes. This view receives confirmation from the position, in the adult, of the superior articular surface in the seventh cervical vertebra on the root of the transverse process, the continuity of the portion of bone bearing this articular surface with the transverse process not being here interrupted by any lateral notch such as exists in the higher cervical vertebrae. The extreme slenderness, too, of the true transverse processes in the upper cervicals when compared with the dorsal transverse processes bears out the notion that the cervical articular pillars really belong, in part at least, to the transverse processes. In this light, the difficulty of accounting for the occurrence in connection with these articular pillars of secondary processes, which, in the dorsal region, are closely associated with the true transverse processes, disappears, and a fresh argument is supplied in proof of the homology of the projections on the cervical articular processes.

As the markings on these articular processes are for the attachments of muscles, we naturally look for some evidence as to their true character from the series of the slips of the deep muscles of the back. Portions of three muscles, viz., the trachelo-mastoid, the complexus, and multifidus spinæ, have attachments to articular processes in the cervical region. The exact point of attachment, however, differs in the different muscles. For while the complexus and the trachelo-mastoid slips are attached to the lateral aspect of the articular pillars, the origins of the multi-

fidus spinae, and these alone, spring from their posterior surface. Extending, as it does, along the whole length of the column, the multifidus spinae affords a good guide in the determination of the serial homology of the bony points to which its various slips are attached. Its slips arise in the cervical region, from the backs of the articular pillars; in the lumbar region, from the mammillary processes; in the dorsal, from those points of the transverse processes which correspond with the lumbar mammillary processes. This seems to make it plain that the projections from the back of the articular processes in the cervical vertebrae must represent mammillary tubercles. The intimate relationship which exists between these projections and the multifidus spinae muscle is shown by their not occurring as a rule above the fourth cervical vertebra, above which the line of origins of the muscle does not extend. If any markings do appear on the articular processes of the third cervical they are very slight.

Corresponding to the movement of the secondary processes from the transverse process of the first dorsal vertebra towards the cervical articular pillars, there is a gradual change in the points of attachment of the trachelo-mastoid, complexus, and multifidus spinae muscles. The lowest cervical slips of these muscles are found to have passed out on to the transverse processes, so that at the seventh cervical vertebra these muscles, not being attached, as they are above, to the articular pillars, have begun that movement outwards by which they reach towards the tip of the transverse process in the dorsal region. The manner in which the change in position of the origins of these muscular slips takes place seems, therefore, to complete the proof of the presence in the cervical articular pillars of projections which, in the dorsal region, are merged in the tips of the transverse processes.

The not infrequent occurrence of a slight rounded projection from the lower and outer part of the roughness at the back of the articular pillars, as on the left side of the fifth cervical (Plate X.), seems to indicate that the accessory processes are also represented in the cervical region.

The recognition of the presence in the vertebrae of the neck of parts in series with the lumbar mammillary and accessory processes, enables us to follow out the true relations of the posterior cervical inter-transverse muscles. When we consider the points of attachment of these muscles, and the position which we have seen the representatives of the secondary processes to occupy in

the cervical vertebrae, it is difficult to see how they can be, as Joh. Müller (*Anat. der Myxinoiden*, p. 245) considered them, similar to the *inter-transversales mediales* of the lumbar region, and to the muscles in series with those, viz., the dorsal inter-transverse muscles; but if we recognise the essential continuity of the transverse processes and the ribs in the primary costal circle, and the secondary importance of "the exact place and manner in which they are articulated or ossified to the vertebral column" (Cleland, *loc cit.*, p. 125), then the serial homology of the posterior cervical inter-transverse muscles, with the *levatores costarum*, which are, as Müller has pointed out, the representatives in the thorax of the lumbar *inter-transversales laterales*, is rendered probable. No doubt, the outer part of the lumbar transverse process is considered as serially homologous with a rib (*Quain's Anat.*, 9th edition, vol. 2, p. 24), and so the *inter-transversales laterales* connect succeeding rib-elements, while the *levatores costarum* have their upper ends fixed to the tips of the transverse processes, and in the cervical region the posterior inter-transverse muscles pass from true transverse process to true transverse process. The apparent difficulty, however, of recognising a set of muscles, with different points of attachment in different regions, as forming one series, is got over by taking that comprehensive view of the nature of parts forming the primary costal circle, to which we have alluded, and at the same time bearing in mind the various forms and degrees of development of the costal arch. It may here be noted that a change in the attachment of muscular slips in passing from the dorsal to the cervical regions, similar to that just mentioned, is undergone by the *serratus magnus* in ascending to the neck as *levator anguli scapulae*. The slips of the *serratus magnus* arise from the ribs, those of the *levator anguli scapulae* from the posterior tubercles of the cervical transverse processes. So that it seems as if the shortening of the bony element, representing a rib, till it lies in front of the anterior divisions of the spinal nerves had, both in the case of the posterior cervical inter-transverse and of the *levator anguli scapulae* muscles, left these muscles in the plane of the costal circle, though now attached to the tips of the true transverse processes, and not to the prolongations articulated with them.

The anterior inter-transverse muscles in the cervical region, placed in front of the anterior divisions of the spinal nerves, seem

to be in series not with the lumbar *inter-transversales laterales*, but with the internal inter-costal muscles.

LOCK LIMITING EXTENSION OF THE NECK.

A point, which, so far as I know, has not been previously noticed, is the presence, in the upper dorsal region, of an arrangement by means of which a locking of the vertebrae is produced, determining the limit of extension of the neck. Just below the inferior border of the upper articular surfaces in one or more of the upper dorsal vertebrae, there occurs on each side, in almost all the columns examined, a more or less well-marked transverse furrow, bounded inferiorly by a ridge which passes outwards and fades away on the transverse process (Plate X., c). Between this ridge and the articular surface the groove lies, which in extension of the neck receives the sharp lower edge of the inferior articular process of the vertebra above, and thus helps to check further movement in a backward direction.

In six out of the thirty-two specimens examined, the grooves were not distinct; but in the other instances grooves were present in one or more of the upper dorsal vertebrae, while in ten cases the first dorsal alone had such grooves. Amongst those last, by far the best examples of these grooves occur, having a well-defined lip bounding the furrows posteriorly, and seven out of these ten were specially well marked in this respect.

These locking grooves, then, occur in their most typical form in the first dorsal vertebra, and so are situated at a point just at the root of the freely movable column of the cervical vertebrae, where the upper dorsal vertebrae, both by their comparative fixture and inclination forwards, oppose over-extension of the neck. If we bear in mind the great mass of the extensor muscles in the neck and upper dorsal region, acting in extension of the head and neck, and that the freest movement in the upper part of the column occurs between the lowest cervical vertebrae, while a very sudden restriction of mobility takes place in passing from these to the upper dorsals, it is not difficult to account for the existence of these locks as aids to the limitation of extension, or to understand why they should present their strongest features in the first dorsal vertebra, and should not be found in the lower dorsals.

An interesting proof of the normal function of these grooves is found in their excessive development under pathological conditions. In the skeleton of a hunchback, preserved in the Anatomical

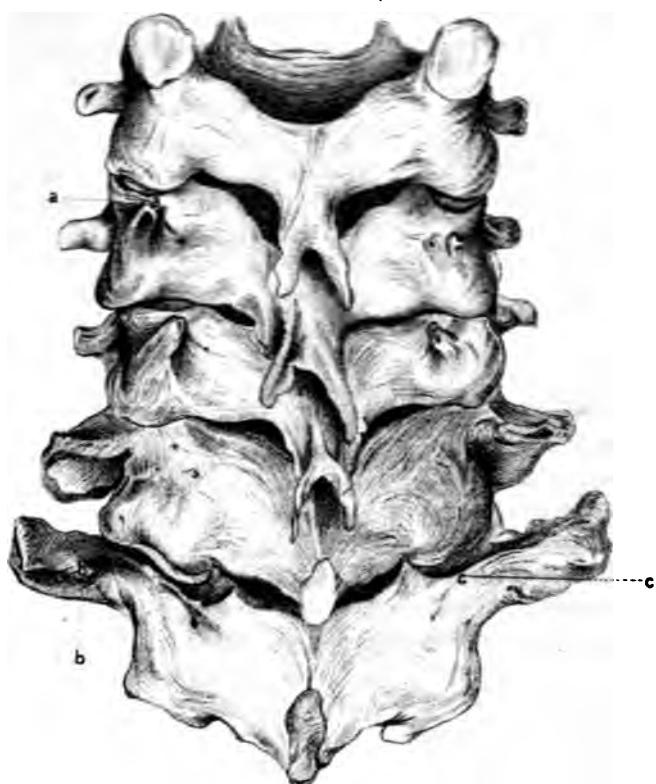
Museum of Glasgow University, an excessive acute curvature in the lower dorsal region has so altered the normal curve of the upper dorsal vertebrae, that, instead of a convexity posteriorly, they present a concavity continuous with the cervical curve; and, being thus thrown into over-extension, nearly all the dorsal vertebrae exhibit a great development of the locking grooves behind the superior articular surfaces.

The locking of bone against bone is exemplified in many of the other joints of the body, *e.g.*, the elbow, the wrist, and the ankle, the principle involved being, as Dr. Cleland informs me, one on which Goodair was wont to lay great stress, the limit of movement of a joint, according to him, never depending entirely on the resistance of stretched ligament, but rather on the locking of bone against bone.

EXPLANATION OF PLATE.

VIEW OF THE FIRST DORSAL AND LOWER FOUR CERVICAL VERTEBRAE DESCRIBED IN THE TEXT.

- (a) Process on the articular pillar of the fifth cervical. Similar processes are seen on both sides of the sixth, and a trace of such a projection on the right side of the fifth.
- (b) Projection from the transverse process of the first dorsal.
- (c) Groove for the reception of the lower edge of the inferior articular process of the seventh cervical.



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XXX.—*On Development and Abnormal Arrangement of the Intestine.* By R. BRUCE YOUNG, M.A., M.B., C.M.

(Plate XI.)

[Read before the Society, 12th May, 1886.]

THE interest attaching to any individual instance of abnormality in bodily structure must always be increased, when, besides describing the peculiarities of the case in itself, we can point to the original pathological interference, and trace, with the aid of development, the mode in which it has led to the divergence from the normal. Sometimes an abnormal arrangement affords a picture, more or less altered in detail by subsequent growth, but still true in its essential features, of the state of matters which existed at the time when the change took place, and thus not only are we enabled to explain the adult condition, but light may conversely be thrown on the mode of development of the parts concerned. Acting on such considerations, I venture to add another to the list of recorded misplacements of the great intestine.

ABNORMALITY.

The subject was an adult male. The cæcum projected into the pelvis, and with the lower part of the ascending colon lay free on the left side of the middle line (Fig. 1, *a*). At a point just over the left common iliac artery the colon first became bound to the posterior abdominal wall. Thence it passed obliquely upwards for about four inches, still in contact with the wall of the abdomen, till it reached a point on the left side of the aorta at the level of the superior mesenteric artery and close to the upper end of the duodenum. Turning abruptly to the left, the bowel now descended as low as the iliac fossa, and thence passed upwards in a series of closely packed convolutions to reach the splenic flexure. In this part of its course the intestine was more or less adherent to the posterior parietes. From the splenic flexure the descending colon ran normally into the sigmoid flexure and rectum.

After turning to the left, the colon in the first $3\frac{1}{2}$ inches of its descent was bound to the upper end of the ascending portion. The membrane by which these parts of the colon were bound together was $\frac{1}{2}$ -inch broad, and, posteriorly, the lowest inch of it was not adherent to the abdominal wall, so that inferiorly it terminated in a free margin (Fig. 1, *g*). The stomach lay entirely on the left side of the middle line, its pyloric end not having crossed to the right. The duodenum bound down throughout the whole of its course to the abdominal wall passed into the jejunum on the right of the aorta, consequently the ligament of Treitz was stretched obliquely across the aorta to reach it. The duodenum descended to about an inch above the origin of the right common iliac artery, and from its lower border a frænum extended downwards. This probably corresponds with the similar fold which was found by Mr. Treves in the human foetus and in animals, and from which he holds that the plica duodeno-jejunalis is developed—its existence in the present case being a persistence in the adult of the foetal condition.*

The mass of the small intestine lay on the right side—the ileum at its lower end passing across to the left to join the colon (Fig. 1, *d*)—consequently the mesentery sprang from a line descending obliquely from the right towards the left side.

From the ileo-cæcal valve to the anus, the great intestine measured 4 feet 8 inches, the small intestine 19 feet 1 inch from the same point to the duodenum.

As regards their branches and the parts of the intestine supplied by them, the superior and inferior mesenteric arteries were normal,

* Treves' "Anat. of the Intestinal Canal and Peritoneum in Man," pp. 19 and 24. In this connection I should like to say that a renewed examination of the peculiar fold alluded to in my previous paper on "Abnormal Disposition of the Colon" (*Jour. of Anat. and Phys.*, October, 1884), convinced me that, as suggested by Mr. Treves, it was peritoneal. The fold, however, did not spring from the lowest point of the duodenum, for the apex of the curve of the abnormally adherent duodenum round the tip of the gall-bladder must not be confused with the lowest point of its normal bend. It was formed of peritoneum which belonged to the left layer of the meso-duodenum, and it passed down to the upper surface of the left layer of the mesentery. These facts, apart from the existence in the present case, in a very different position, of a fold like the one to which he refers, seem opposed to the conclusion that the fold referred to in my previous case is similar "to the vertical fold in animals." In that instance the fold had, I believe, been produced by the upper part of the duodenal curve having become adherent to the liver round the apex of the gall-bladder, so as to pull out a duplication of the serous membrane.

except that the branches of the superior mesenteric to the small intestine ran towards the right, those to the great intestine towards the left, so that if the ascending colon had been twisted over to the right the branches would have had their normal course.

EXPLANATION.

In the position, on the left side, of the whole of the large intestine, and in the arrangement of the branches of the superior mesenteric artery, this case presents resemblances to others that have been recorded, and like them, seems to point to non-completion of the twist in the developing intestine as the cause of the adult malposition. It differs, however, from the case which I previously described (*loc. cit.*), in that the length of the colon shows no such arrested development as was there present. The great intestine has exactly the measurement given by Mr. Treves (*op. cit.*, p. 8) as the average in the male, so that, while the twist around the superior mesenteric artery as an axis has been interfered with, the cause which led to this has not been such as to affect the growth of the bowel.

The stage of development at which the departure from the normal took place being established by the relation of parts in the adult, we have still to discover a cause for that change, and in this instance the adhesion existing between the upper part of the ascending portion of the colon and the succeeding part of the bowel affords a sufficient explanation. In a human foetus, 1 inch long from vertex to coccyx, in which the rotation of the bowel has not been completed, the cæcum projects from the primary loop of intestine at some distance from its lower end, and the portion of colon between the cæcum and the neck of the loop lies free and movable, attached only by the mesentery of that loop (Fig. 2). From the neck of the primary loop, the colon passes in a curve to the straight tube leading to the anus. Now if, as the result of some inflammatory process, adhesions were formed between the lower end of the primary loop and the descending portion of the colon, close to the point at which the one curves into the other, then, as development proceeded, further rotation of the bowel would be prevented. Provided that the adhesion were limited, and not such as to prevent the possibility of after-growth, the bowel might go on developing with the surrounding parts, and ultimately the state of matters would be as in the present case. The supposition of such a cause having been in action to

prevent the normal passage of the cæcum to the right is borne out by the existence of a membranous layer between the upper end of the ascending part of the colon and the succeeding portion of the bowel. That adhesion was limited in extent is rendered probable by the free growth of the bowel towards the cæcal end of the colon, by the normal descending colon, and by the development under peculiar conditions of a transverse colon, for as such the coils of intestine lying in the left lumbar region and passing up to the splenic flexure must be regarded.

That a portion of the colon enters into the formation of the primary intestinal loop is universally admitted, but it seems to me that due weight has not been given to the influence of this on the manner in which the cæcum passes to its adult position. Tracing the development of the bowel in a series of foetuses, this part of the colon is found in the younger specimens to be passing in front of and over the small intestine, and is still free from the abdominal wall in the mesentery of the primary loop, while the cæcum is at such a distance from the neck of the loop, that if twisted to the right side it reaches the lower part of the lumbar region just above the iliac fossa. In a foetus 5 inches in length, the part of the colon to the right of the middle line has, owing to the growth of the bowel itself, and of the surrounding parts, become attached to the posterior abdominal wall by peritoneum forming a meso-colon for this part of the intestine, while the cæcum lies in the right lumbar region at the lower end of the kidney. In foetuses, up till the time of birth, the state of matters remains pretty much the same.

The generally accepted notion of the progress of development of the large intestine is, that the cæcum, after crossing over the small intestine, passes to the right hypochondrium and then pushes downwards towards its ultimate position, forming the right half of the transverse and the ascending colon. So far from this being the true state of matters, the portion of the colon, from which in normal circumstances the ascending and the right half of the transverse colon are developed, already exists as part of the primary loop, before the twist of the intestine to the right occurs; so that when the rotation does take place, it is the whole loop with its peritoneal surroundings which revolves round the superior mesenteric artery until the cæcum lies in the lower part of the right lumbar region, separated, however, in the first place, from the abdominal wall by two opposed surfaces of peritoneum.

When the bowel becomes fixed to the abdominal wall, the cæcum is already just above the right iliac fossa, and only a slight downward growth is needed to carry it to its adult position. In this connection it is interesting to note that Mr. Treves (*op. cit.* pp. 39 and 40) has pointed out that there never is a meso-cæcum in the human subject, and that the cæcum is entirely covered behind by peritoneum which is, in the majority of cases, reflected from the posterior surface of the ascending colon—the commencement of the ascending colon, as well as the cæcum, being thus completely invested by the serous covering. This seems to confirm the idea that the attachment of the cæcal end of the colon in the lower lumbar region is followed by a growth downwards of that portion of the bowel carrying with it a complete covering of peritoneum.

The portion of the colon to the right of the middle line, when it becomes attached to the posterior abdominal wall, has, as Mr. Treves (*op. cit.*, p. 52) recognises, an oblique course running from the right side below upwards towards the splenic flexure, and this disposition is "still marked in the foetus at full time, and even in some young subjects." The obliquity in position of this part of the colon Mr. Treves associates with the great size of the liver, and he further states "that it is not until the liver has regained its normal proportions with reference to the other viscera that the hepatic flexure becomes well marked, and the right segment of the colon acquires the position that is familiar in the adult." Even in the adult the hepatic flexure is often ill-marked, and, compared with the splenic flexure, is always of less importance, both as regards distinctness and date of appearance.

Those cases in which the cæcum in the adult occupies a situation on the right side higher than the lumbar region are, in the light of the present facts, probably to be accounted for by some interference with the growth of the colon at a time when the primary loop still lay free in the abdominal cavity, the part of the colon to the right of the middle line not yet having been bound to the posterior abdominal wall.

ADDITIONAL OBSERVATIONS ON DEVELOPMENT OF THE INTESTINE.

In the foregoing remarks the development of intestine has been alluded to only in so far as it concerned the instance of mal-position described, but the opportunity may be taken of directing attention to a few other points which have come under the writer's

notice when making examination of foetal conditions required in that connection.

In the foetus referred to (Fig. 2) the duodenum curves underneath the root of the superior mesenteric artery, carrying with it the upper end of the jejunum. Even at this early stage, before the part of the colon at the neck of the primary loop has reached farther than the left side of the superior mesenteric artery, the duodenal curve has been formed. Thus, while no doubt growth in opposite directions at the two ends of the primary loop causes rotation of the bowel, it is probable that the passage of the lower end of the duodenum with the upper end of the jejunum underneath the artery determines the direction of this rotation.

As regards the distribution of the superior mesenteric artery, there is a point to which I wish to direct attention. This artery forms the axis round which rotation of the primary loop takes place, and from its opposite sides come off the *vasa intestini tenuis* and the colic branches. Thus the part of the ileum belonging to the inferior limb of the loop receives its blood-supply, not from the *vasa intestini tenuis*, but, as Tiedemann correctly represents, from the anastomosis between the ileo-colic branch and the termination of the main trunk of the superior mesenteric artery. The length of the part of the ileum so supplied (taking the ileo-colic junction and the prolongation of the line of the stem of the superior mesenteric as limits) varied in the cases which I examined, from 1 foot some inches to 3 feet. This represents in the adult the portion of the ileum, which was inferior to the apex of the primary loop—its upper limit marking the position of that apex. In connection with this it is interesting to note the position at which true diverticulum of the intestine occurs. In eight specimens obtained from the dissecting rooms and preserved in the Anatomical Museum of the University of Glasgow, the recorded measurements of the distance of this diverticulum from the ileo-caecal junction range from 20 inches to 4 feet.

The stages of development of the sigmoid flexure do not seem to have been up to the present described. In a foetus, 3 inches long, I find the colon descending in a comparatively straight course from the well-marked splenic flexure, until at its lower part it bends backwards towards the posterior abdominal wall, and, entering the pelvis, passes down to the anus. The free meso-colon is still attached to the posterior abdominal wall, between the left kidney and the middle line; and there is no

sigmoid flexure. At a later stage, in a foetus about five inches in length, the colon is arranged round the outer border of the kidney, which is relatively very large (Fig. 3). The line of attachment of the descending colon to the posterior abdominal wall is now external to the left kidney, and its meso-colon has been obliterated. From the outside of the kidney the bowel curves inwards round its lower end, and then passes into the free loop of the sigmoid flexure. The appearances suggest that the kidney, in its rapid increase, has encroached on the left layer of the primitive meso-colon, while the growth of the abdominal wall has pulled that layer to the side, and thus the colon is laid along the outer and lower borders of the kidney, leaving the lower part of the bowel with its free peritoneal attachment. The part of the colon which curves round the lower end of the kidney forms, with the part above described as bending back to enter the pelvis, the neck of a loop, which, left with a free meso-colon, projects upwards and towards the right (Fig. 3, c). This Mr. Treves recognises (*op. cit.*, p. 62) to be the condition of the sigmoid flexure in a foetus of 5 inches. Thus the sigmoid flexure is formed with a meso-colon, representing the lower and somewhat displaced part of the primitive mesentery. The persistence of the free meso-colon of the sigmoid flexure is probably to be associated, not only with the existence of this loop of bowel, but also with the fact that the demands upon the peritoneum in this region are less than elsewhere in the abdomen.

In the foetus, whose intestines are represented in Fig. 2, a curious condition of the cæcum is seen. Here, instead of a single primitive cæcum, there project from the great intestine, at its junction with the ileum, two small pouches, that on the left side being slightly the larger. Meckel (*Tabulae Anatomico-pathologicae, Fascic. III., Tab. XXIII.*, Fig. 9) figures a case in which the cæcum was bifid and alludes (*Fascic. III.*, p. 14) to two other instances of a similar kind.* Unfortunately, owing to want of material, I have not had an opportunity of examining, on this point, other human foetuses of a similar or an earlier date; but the existence, among mammals, of two cæca in the armadillo, two-toed anteater, and manatee, and the characters of the vermiform

* Mr. Lockwood (*Brit. Med. Jour.*, 1882, vol. ii., p. 574) refers to Fig. 4 of the same Plate in Meckel's work as representing a case in which there were two cæca, but the description of that Figure shows that it was the rectal end of the colon that terminated in two blind pouches (*saccis cæcis*).

appendix in the wombat, as well as the adult condition in the human subject, seem to point to the possibility of extended observation, which I hope to carry out, revealing in the fact here noted a significance beyond that which attaches to it as a casual peculiarity.

EXPLANATION OF PLATE.

Fig. 1.—Misplacement of the colon described in the text. The liver has been turned upwards to afford a better view of parts.

- a.* Cæcum lifted out of the pelvis.
- b.* Duodenum.
- c.* Jejunum.
- d.* Ileum crossing to the left to join the great intestine.
- e.* Beginning of transverse portion of the colon.
- f.* Sigmoid flexure.
- g.* Membrane binding together parts of the ascending and transverse portions of the colon.

Fig. 2.—Enlarged view of stomach and intestines of foetus 1 inch long. The liver has been removed.

- a.* Remains of umbilical cord.
- b.* Coils of small intestine which lay in the neck of the umbilical vesicle.

In the upper part of the Figure, the stomach and the beginning of the duodenum are seen. The lower part of the duodenum, carrying with it the upper end of the jejunum, curves beneath the superior mesenteric artery, and consequently these parts of the intestine are hidden from view. From the bifid cæcum the great intestine can be traced up to the neck of the primary loop, where it passes into descending colon.

Fig. 3.—Descending colon and sigmoid flexure, with left half of transverse colon of foetus, about 5 inches long.

- a* is placed on the peritoneum covering the left kidney.
- b.* Descending colon.
- c.* Sigmoid flexure.
- d.* Left half of transverse colon.

Fig. 1

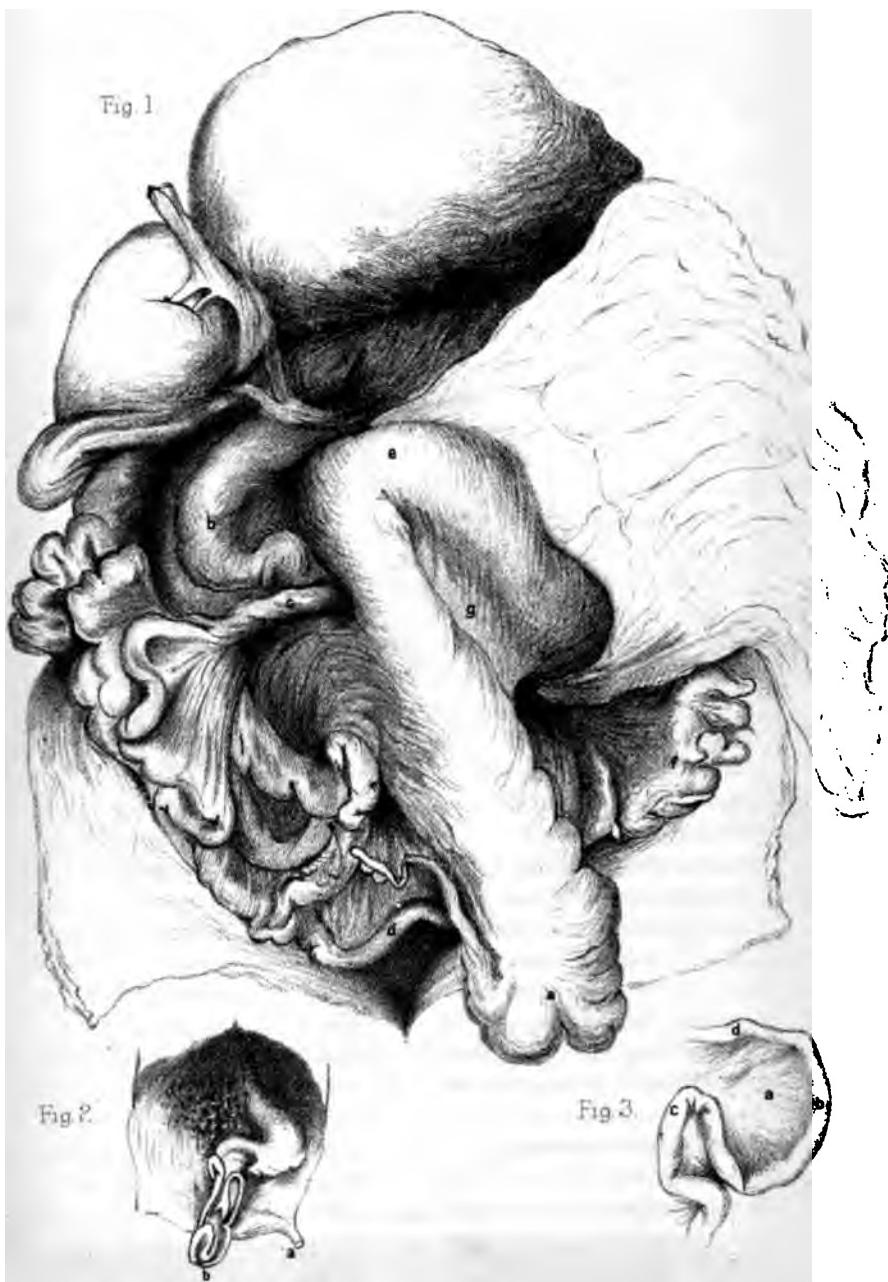


Fig. 2.



Fig. 3.



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XXXI.—*On The Lucigen: a new Industrial Light.*

By J. B. HANNAY, F.R.S.E.

[Read before the Society, 18th April, 1886.]

FROM the earliest times oil has been the chief source of artificial light for man. In some parts of the world hydro-carbons were found existing naturally in the rocks or soil and served both as a fuel and illuminant. In pastoral countries the oils obtained from animal fat were those most naturally used for the production of light. In countries where the product of fishing formed the main source of food for the people fish oils came to be burned for light. Lastly, in modern times, when chemists began to tamper with nature's handiwork it was found that oil could be obtained by submitting certain minerals to the action of heat, in a retort, and the oil so obtained forms one of the great sources of artificial light at the present day. I am about to bring before you a still further development of the use of oil for lighting. To burn these oils, many contrivances have been devised, and as most of them will only yield a clear smokeless flame when urged by a special blast of air, these contrivances have generally included some means of causing a blast of air to impinge on the burning flame. This has generally been accomplished by utilising the heat of the flame itself to cause a draught in a funnel, although there are lamps in existence which create the draught in a positive manner by means of a fan. As the funnel must surround the flame, it must be constructed of glass, and herein lies the obstacle which has prevented oil from being used as an illuminant, for producing large flames in the open air—the slightest spot of rain touching the glass funnel causes instant fracture.

Now, oil, by its setting free a large quantity of carbon in burning, is specially adapted for producing brilliant dense lights, as gas affords a flame much too pale and transparent to thoroughly illuminate large spaces or enable one to work at minute details.

Hence, electric light, although very much more costly and involving constant attention and expensive renewal or repair of plant, has been chosen for illumination for large spaces, in place of either gas or oil.

The apparatus dealt with in this paper forms the first step in a new departure which will, it is believed, revolutionise our ideas as to the use of oil as an illuminant. It is important that at this time this step has been taken, as, from explorations and borings into the earth's crust, it appears that in nearly every part of the world there are immense stores of oil laid up for us at no great distance below the surface. It is only necessary to point to America as a modern instance, but petroleum exists in as great quantities in South America, Australia, Asia, India, Europe, and has now been found in Africa. In one part of the world, indeed, the petroleum is one of the oldest commercial industries of which any record exists, as this oil has been flowing from wells on the shores of the Caspian Sea for thousands of years, and has been transported into Persia and India since very remote times. In fact, when Sir Humphrey Davy discovered sodium and potassium, he found he could preserve them only in "rock oil," as is often quoted in chemical text-books yet, and this oil was brought from Persia, where it had been obtained from the Caspian Sea. As far back as 1754, when Jonas Hanway visited the Caspian in the interests of a powerful trading company called the Russian Company, schemes were proposed for having a trade in this rock oil or petroleum.

As the gaseous and low boiling point petroleums escape from the ground in the Baku district, just as they do in America where they are using them for smelting, &c., and as these gases had at some very remote period become ignited, the superstitious had considered them supernatural, and temples were built over the fissures in the rock from which the flames issued, and a regular system of worship instituted with its priests, offerings, pilgrimages, and other vagaries which invariably arise from the human love of the mysterious.

The old trade was carried on by merely digging holes in the ground, which filled with oil, and which was then put into jars and transported by camels to the markets—much as we are told of in the veracious history of Ali Baba. But with the development of the American industry new ideas were imported, chiefly by Mr. Ludwig Nobel, a well-known Swedish chemist, and the supply of

oil which may be obtained is so immense, that one famous fountain well which ruined its owners threw up as much oil as the whole 25,000 wells in America have produced.

The oil at Baku seems to lie in large cells, quite separate from each other, so that a bore put down a hundred feet from an active well may strike oil at a totally different level from the well already bored, and the oil taken from it in no way affects the old well.

The oil regions in Asia and Europe, although until very recently unexplored and mostly yet unwrought, are very much more extensive than in America. They extend from Rangoon through India, Afghanistan, Persia, the Caspian, Crimea, Austria, Hungary, and even through Italy into South France and Spain. In the latter countries it mostly occurs in the solid form as asphaltum. But as yet the richest part occurs on both sides of the Caspian Sea and under the sea, as large quantities of oil and gas are found rising to the surface of the water from the rocks below. The crude oil, which is quite suitable for the kind of lamp I am about to show you, can be had at Baku for a few pence a ton. The residue of the oil after the refining operations have been gone through is equally suitable, and millions of gallons of this were run to waste for want of an outlet for it. Only a few square miles of this petroleum country have yet been wrought, and when we consider that there are hundreds of square miles ready for working, it will be seen that there is oil enough here to light the world for generations. One bore has given as much as 600,000 gallons per day. Pipe lines are being constructed to the ports on the Black Sea, and soon this Russian petroleum will rival the American in Europe.

Besides these enormous supplies of oil from natural sources, there are artificial supplies which have been increasing year by year, and new supplies are opening up from improvements in various manufactures. I allude to the heavy creosote oils from coal gas manufacture, which contain much naphthanene, and the new creosote oils which are being obtained in such enormous quantities in the treatment of blast furnace gases for ammonia. It is wonderful how one discovery, by causing chemists to work on certain products, creates other substances for which new outlets must be found. The discovery of the analine dyes led to immense works being established for the treatment of those complex liquids obtained in the distillation of coal, and when all the immediately

useful substances have been extracted there remains behind large quantities of oil belonging to a class for which no large market had been found. These oils, called generally creosote oils, because they contain a considerable quantity of that body, have been gradually accumulating in this country till they are now held in immense quantities—single firms having millions of gallons stored up. This oil is used in limited quantities as a preservative of timber, but this business, large as it is, only uses up a small fraction of the oil produced. So great has the pressure become that the more important firms are making energetic efforts to have this oil used as fuel. At present there seems no great likelihood of this proving remunerative, because if we disregard the ash in coal the heating power of the oil is little if anything greater than coal, and as the latter can be had in Britain at all the principal ports at a price ranging from 7s. to 10s. per ton, the oil would require to be delivered at nearly the same rate, which mean about one halfpenny per gallon. Now the carriage and cooperage of casks would cost this sum alone, so that the oil would require to be given away. Were a ship properly fitted with tanks, and the oil delivered in tank waggons, the expense of handling might be much reduced; but with coal at present prices, I think the chances of oil being profitably employed as a substitute are remote.

The second source of this creosote oil of which I spoke is iron smelting. The profits of iron smelting having arrived at a vanishing point in this country, the iron-masters have turned their attention to the saving of all bye-products of the smelting furnaces, and as considerable quantities of ammonia are cooled during the heating of the coal, which is fed in at the top of the furnace, plant has been erected at Gartsherrie Iron-works and elsewhere for the extraction of this ammonia from the blast furnace gases. During this process considerable quantities of creosote oil are also obtained, and this is separated from the ammonia liquor as another product. Were all the blast furnaces of Britain to adopt this method, immense quantities of this oil would be obtained.

There are other sources, such as coke-ovens, from which additional supplies of this oil will no doubt be obtained. Chemists have long recognised that there is a great prize for anyone who will work out some industrial process by which these oils may be made into some useful substance for which there is a large demand, and many have been the analyses, distillations, oxidations,

chlorinations, and reductions with which chemists have tortured these useless oils, to try to find a method of driving them to join the band of substances useful to mankind. I had myself been devoting various leisure periods to the inquisition of outcast oils, and rendering my laboratory odorous with their unsavory emanations, when a new solution of the question was brought to me by a very clever young engineer, Mr. James Lyle, who sought my aid in the development and commercial arrangement of an apparatus for producing light from these very oils. I knew well that any ordinary method of burning these oils was quite useless, and when lighting occurred to me I always thought of domestic lighting; but Mr. Lyle's engineering experience showed him that there was urgently wanted a large light for industrial purposes, which must be cheap, easily managed, and which must give a broad glow to penetrate every corner of the work, and allow men to clearly see details. Mr. Lyle saw that the light required need not be a very elegant or silent one, as the places where it was most required—viz., engineering works—are places where noise reigns triumphant, and where elegance yields in everything to utility.

I had personally discovered that the distance which separates the successful experiment from the commercial realisation is a very long one, and is to inventors generally the desert waste on which their finest energies perish. Having luckily been able to complete my journey across this arduous plain several times, I had gained the necessary experience of the road, and had organised such a commercial machine as made me feel pretty confident that it could pilot any healthy invention to success. Arrangements were made for Mr. Lyle to continue his experiments under the wing of my company, and I joined Mr. Lyle in devising variations and improvements on the original idea, which have now grown into a widely applicable invention.

Mr. Lyle's experiments date from 1883, and in the autumn of 1884 a successful form of the lamp was fitted up and used in Messrs. Bow, M'Lachlan, & Company's Works in Paisley. The original form of the lamp consisted in a small tank with a long double upright tube, having the burner at the upper end, the tank forming the stand, as it were, for the light. The pressure required to raise the oil up the long tube—say 12 feet—was found to be inconvenient, and, besides this, the burner was rather unsteady, so the form was altered. After a large number of experi-

ments, a form was reached, which is illustrated below, and which serves all the purposes required. The troubles we had to overcome were various. The creosote oil which results from gas manufacture in England was frequently a saturated solution of naphthalene, so that when the oil became chilled by being exposed to frost it became too thick to pass the nozzle. A second trouble arose from the fact that as the compressed air travelled through the supply tubes it deposited moisture which on passing through the flame caused it to go out for a moment, and it required to be relit.

Both these troubles were got over by the simple expedient of heating the air, and allowing the hot air to surround the inner

tube containing the oil. This arrangement converted any water in the air-tubes into steam, which has no effect on the flame, and also warmed the oil, thus rendering it limpid and ensuring its passing the nozzle. The lamp thus completed is shown in Fig. 1.

Varieties of this form of lamp have been constructed, such as an angle-light, shown at the margin (Fig. 2), which casts no black shadows below, owing to the flame being out beyond the tank; a horizontal flame lamp level with the top of the tank, for throwing a powerful light low down to illuminate the flat bottoms of ships in dock; and a bracket-lamp which

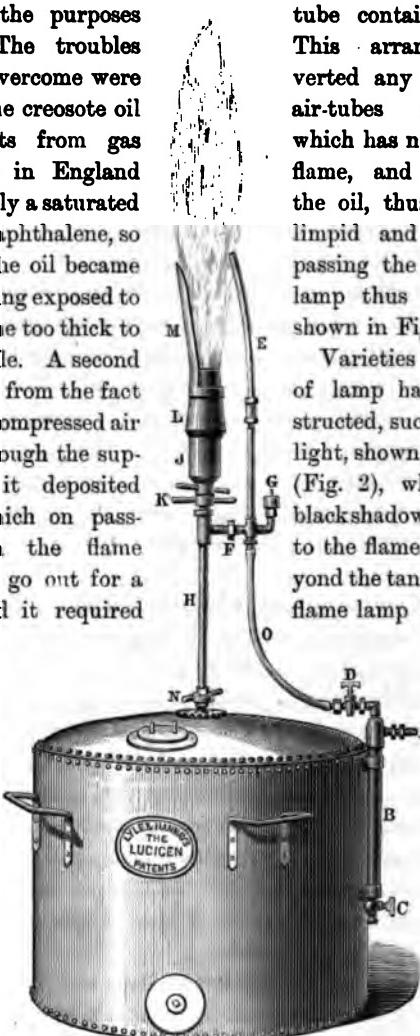


FIG. 1.

may be used for lighting up large workshops, having only one central tank for oil, and the air and oil led by separate pipes throughout the building to the various burners.

Where dry steam can be had the "Lucigen" produces nearly as good a light by steam as by air, and a form of the apparatus has

been prepared by which the heat of the lamp produces sufficient steam for its requirements.

This lamp simply requires a small supply of water.

It will be seen that the apparatus is capable of being adapted to various circumstances, and one form or another will meet the requirements of city street lighting. In cities like Paris, where compressed air is supplied through the streets, the adaptation is easy, and where water is abundant, compressed air is easily obtained, but, where neither of these conditions exist,

the form which generates its own steam can be used. This form, of course, requires a lantern, and is hence more expensive than the others, as with such a large flame the lantern requires to be 6 feet in diameter.

For occasional use, such as break-down vans, and odd purposes, when no supply of steam or water is to be had, we have prepared a hand-pump capable of supplying two "Lucigens," so that, if the break-down van has this apparatus as a part of its outfit, and the "Lucigens" are kept full of oil, the railway engineers have the power of producing a brilliant light over a large area at a moment's notice, even far away from steam or water. This apparatus is shown in Fig. 3.

The advantages of the Lucigen over every other form of light yet invented for illuminating large spaces consist in the great body of flame produced, yielding a broad glow of light, which gives an effect more nearly approaching daylight than anything yet invented, while as it uses a waste product the cost is very small.

The large size gave on photometric test a candle-power of 2,796, and yet very competent judges pronounced the illuminating effect for doing work by it to be equal to four electric arc lights of 2,000 candle-power. The small size of the Lucigen gives a flame of



FIG 2.

about 300 to 400 candle-power, and is designed for use where a

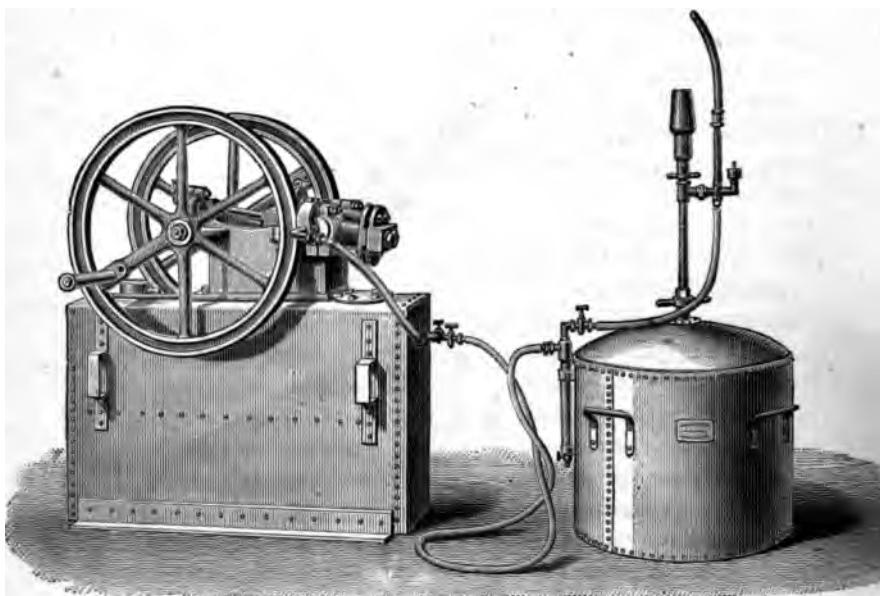


FIG 3.

light of moderate power is wanted close to the work, as in rolling mills, &c., as the gentle broad glow it gives enables the workmen to see their work distinctly, and they are not misled by the intense shadows cast by the arc lamp.

Fig. 4 shows a compressor of about one horse-power, with air-receiver attached, capable of driving eight lights of about 20,000 candle-power, while at either side is shown a large and small Lucigen.

In estimating the working value of any light the actual candle-power conveys very little idea of the utility of the light for doing work by. This arises from the fact that the eye is by no means an absolute instrument, but is largely affected by the intensity of the source of light illuminating the work. The pupil of the eye closes in when near a source of intense light, and so cuts off a large proportion of the light reflected from the illuminated objects, and hence sees them darker. Thus, were the same object illuminated alternately by a 2,000 candle electric lamp and a 2,000 candle Lucigen, it would appear at least four times as well

lit by the Lucigen as by the electric light, because the electric



FIG. 4.

light would all come from a source of, say, 2 square inches, while the Lucigen flame would have a section of about 200 square inches, and is hence 100 times less intense, so that the pupil of the eye does not close in to nearly the same extent as with the intense electric arc. Another point is that the large flame is just like sunlight, it does not cast sharp shadows, and hence there is not that intense contrast of light and shade which makes it so difficult for a workman to appreciate the true details of his work when working with the electric light. This has been so very strongly felt in South Staffordshire that the rolling mills are actually replacing their arc lamps by many small incandescent ones, while one may frequently see men using tallow candles close to their work in shops lit by arc lamps.

Its utility for workshops, railways, engineers, and contractors outside operations has been fully demonstrated, many installations being constantly at work, while the operations of Dredgers, Dock construction, loading cargo at night are more and more being carried on by the aid of the Lucigen.

There is one purpose for which I think its properties might be very usefully employed, with the effect of rendering life and property more safe at sea, with almost no tangible cost. I allude to the fact that were each vessel crossing the Atlantic to light a Lucigen on board each evening at dusk, and keep it lighted all night, any other vessel approaching would see the ship—hull, masts, spars, funnels, and all just as clearly during the night as in day time, and the vessels could steer clear of each without any dubiety as to the course they were pursuing. The red and green lights are very deceptive to mariners in certain weather, the light being visible but the colour uncertain, while the distance of the other vessel is purely a matter of conjecture. With the Lucigen, however, the distance and course of the other vessel would be quite as apparent as in daylight. I think that if this were adopted the number of vessels which mysteriously disappear every year would be very much reduced, and one of the greatest anxieties of steamship travelling reduced to a minimum.

XXXII.—*On some Early Treatises on Technological Chemistry.*

By JOHN FERGUSON, M.A., Professor of Chemistry in
the University of Glasgow.

[Read before the Society, 6th January, 1886.]

**XXXIII.—*John Beguinus and his Chemical Writings.* By JOHN
FERGUSON, M.A., Professor of Chemistry in the University
of Glasgow.**

[Read before the Society, 17th February, 1886.]

NOTE.—These two Papers will appear in next volume.

REPORT OF SECTIONS FOR SESSION 1885-86.

[Received at Meeting of Society on 12th May, 1886.]

1.—REPORT OF THE ARCHITECTURAL SECTION.

During the Session eight Meetings have been held, at which 11 papers have been read. The following is a list of the papers read at the Meetings:—

MONDAY, November 16, 1885.—Opening Meeting, when Mr. William Landless, President of Section, gave his address.

MONDAY, November 30, 1885.—Henry A. Mavor, Esq., read a paper, subject, “The Electric Light as applied to Industrial and Domestic purposes.”

MONDAY, October 14, 1885.—William Howatt, Esq., Measurer, read a paper on “The New Mode of Measuring Mason Work, with Notes on the Brick, Slater, and Plaster Works;” and A. Lindsay Esq., Miller, Architect, read a paper, subject, “Fireplaces and Chimneys.”

MONDAY, January 18, 1886.—Charles Gow, Esq., Decorator, read a paper, subject, “The Combined Decorative Arts of Glass and Colour.”

MONDAY, February 1, 1886.—James Chalmers, Esq., Architect, read a paper, subject, “The Planning and Sanitary requirements of Farm Steadings.”

MONDAY, February 15, 1886.—John Bennie, Esq., Engineer, read a paper, subject, “Hydraulic Machinery for Buildings;” and William Sheriffs, Esq., Sculptor, read a paper, subject, “Electro Deposits of Copper as applied to Decorations.”

MONDAY, March 1, 1886.—David Thomson, Esq., Architect, and W. P. Buchan, Esq., Sanitary Engineer, read papers on “Ventilation.”

MONDAY, March 15, 1886.—William Cairns, Esq., Plumber, read a paper, subject, "Plumber Work."

The thanks of the Section are due to all these gentlemen.

During the Session 25 Associates joined the Section.

The Annual Business Meeting was held on Monday, March 15, when the following gentlemen were elected to office:—

President—James Thomson, Esq., Architect, 88 Bath Street.

Vice-Presidents—T. L. Watson, Esq., Architect, and Alexander Muir, Esq., Builder.

Treasurer—James Howatt, Esq., Measurer.

Secretary—Mr. A. Lindsay Miller, Architect, 121 West Regent Street.

Members of Council—James Sellars, Esq., Architect; David Thomson, Esq., Architect; William Landless, Esq., Architect; Thomas Gildard, Esq., Architect; James Chalmers, Esq., Architect; R. A. M'Gilvray, Esq., Plasterer; William Gilfillan, Esq., Marble Cutter; John Dansken, Esq., Measurer; William Howatt, Esq., Measurer; William Cairns, Esq., Plumber.

(Signed) A. LINDSAY MILLER, *Architect,*
Hon. Secy. of Section,
121 WEST REGENT STREET.

II.—REPORT OF THE GEOGRAPHICAL AND ETHNOLOGICAL SECTION.

During the Session five Papers from the Section were read before the Society. 1st, "Notes on South Africa and the Africanders," by Mr. Arthur Kay, on 18th November; 2nd, "On the Verification of Traditions regarding the First Peopling of certain Islands in the South Pacific," by Dr. G. A. Turner, also on 18th November; 3rd, on "The Ancient Civilization, Trade, and Commerce of Eastern Africa," by Consul H. E. O'Neill, F.R.G.S., on 29th January; 4th, on "China's Northern Dependencies and Colonial Possessions," by Dr. John Dudgeon of Peking, also on 27th January; 5th, "Excerpt from Letter from the Hon. James Blyth, Secretary for Native Affairs in the Colony of Fiji, relating to the Tribe of Beqa's alleged power of walking through Fire," by Mr. Robert Blyth, C.A., on 28th April.

In addition to the above, two papers have been read, which were contributed to the Scottish Geographical Society. 1st, on "East Central Africa and its Commercial Outlook," by Mr. Joseph Thomson, F.R.G.S., on 8th January; 2nd, on "Travels in Madagascar: the Present Condition and Commercial Future of the Island," by Rev. W. Deans Cowan, on 11th March.

To all these Meetings the Members of the Society and Associates of the Geographical Section, and the West of Scotland Members of the Scottish Geographical Society, were invited, and the success of the arrangement for holding these Joint Meetings has been most marked.

Seven Associates have been added to the Section during the Session.

A copy of the Royal Geographical Society's large Map, in sheets, of Eastern Equatorial Africa was presented to the Society, through the Section, by W. G. Blackie, LL.D., President of the Section.

The Council of the Society have recently placed in the Reading-Room a table, with rack for Geographical publications, and for this the Section has to tender its hearty thanks.

In the death, on 11th April, of Mr. James Smith of Benvue, the Council have lost one of their number and one of the most earnest friends of the Section.

OFFICE-BEARERS FOR 1884-85.

President—W. G. Blackie, Ph.D., LL.D., F.R.G.S.

Vice-Presidents—James Stevenson, F.R.G.S.; Sir Michael Connal; Thomas Muir, M.A., LL.D., F.R.S.E.

Secretary and Treasurer—G. A. Turner, M.D., C.M.

Members of Council—Mr. Alexander Scott, Mr. W. Renny Watson, Mr. Robert Gourlay, Mr. Arthur Kay, James Christie, A.M., M.D., Mr. William Ewing, Mr. Nathaniel Dunlop, Mr. James Grierson, Mr. Maxwell Hannay, Mr. William Ker, Mr. Jacques van Raalte.

(Signed) GEO. A. TURNER, M.D., *Secretary*,
 1 Clifton Place, W.

III.—REPORT OF THE BIOLOGICAL SECTION.

The Section has had no Meetings of its own during the Session, but a number of Demonstrations and Papers have been brought forward at general Meetings of the Society.

Professor M'Kendrick demonstrated (1) the action of Biederman's fluid in causing rhythmic contractions of voluntary muscles, and (2) the reducing action of vegetable protoplasm upon salts of silver.

The President, Professor Cleland, communicated a paper upon the presence and explanation of additional limbs and allied deformities.

Mr. William Milne described a new method which he has applied to the classification of the Rotiferæ.

Dr. Yule Mackay read papers on (1) the arterial system of the Chamaeleon; (2) the arteries of the head and neck, and the *rete mirabile* of the Porpoise; (3) Genito-urinary malformations consequent on pelvic deformities; (4) Hermaphroditic malformation of the external genital organs.

Dr. Bruce Young read papers on (1) the Homology of the Cervical Articular Pillars; (2) the development of the Intestine; (3) the Knee-joint.

Dr. Newman showed a case in which he had removed the larynx. The man spoke with the aid of an artificial larynx.

(Signed) JOHN YULE MACKAY, M.D.,
Secretary,
ANATOMICAL ROOMS, UNIVERSITY
OF GLASGOW.

IV.—REPORT OF THE SANITARY AND SOCIAL ECONOMY SECTION.

A Meeting of the Section was held on 4th November, 1885, at which the following Office-bearers were elected:—

President—Dr. Eben. Duncan.

Vice-Presidents—Mr. Alexander Scott and Mr. W. P. Buchan.

Secretary—Mr. W. R. M. Church, C.A.

Members of Council—Dr. Fergus, Mr. J. Cleland Burns, Mr. W. R. W. Smith, Mr. H. K. Bromhead, Mr. Alexander Frew,

**Dr. J. B. Russell, Dr. Carmichael, Dr. Glaister, Mr. John Young,
Mr. Paul Rottenburg, Dr. Christie, Mr. David Barclay.**

It was agreed to recommend that papers by the following gentlemen be read before the Society during the Session, viz.:—(1) Presidential Address from Dr. Duncan; (2) paper from Dr. Simpson of Aberdeen; and (3) paper from Dr. Glaister. Of these, however, the last only was delivered, as, unfortunately, owing to pressure of work, Dr. Duncan was unable to give his Presidential Address, while Dr. Simpson is absent in India.

In their place, however, Mr. Gilbert Thomson, Resident Engineer of the Glasgow Sanitary Protection Association, read a paper on “Relative merits of Tile and Cast-iron Drain Pipes.”

(Signed) **W. R. M. CHURCH,**
Secretary,
75 ST. GEORGE'S PLACE.

V.—REPORT OF THE MATHEMATICAL AND PHYSICAL SECTION.

This Section was reconstituted by a motion passed at the 84th Annual General Meeting of the Society on 18th November, 1885.

The following Office-bearers were elected :—

President—Sir William Thomson, LL.D., D.C.L., &c.

Vice-Presidents—Thomas Muir, M.A., LL.D., and Professor Robert Grant, M.A., LL.D., F.R.S.

Secretary and Treasurer—Robert Franklin Muirhead, M.A., B.Sc.

Members of Council—Peter Alexander, M.A.; Professor James Blyth, M.A.; James T. Bottomley, M.A.; Henry Dyer, M.A., C.E.; Professor William Jack, LL.D.; Principal Andrew Jamieson, F.R.S.E.; Professor James Thomson, LL.D., F.R.S.; William Renny Watson, James Wood, M.A.

During the Session now closing three communications were made to the Society through this Section, viz.:—(1) by James T. Bottomley, M.A., “Modern Modes of obtaining a Vacuum;” (2) by Sir Wm. Thomson—(*a*) showed new forms of Electric Measuring Instruments, including a Milliamperemeter and an Amperemeter, (*b*) new form of Wheatstone’s Rheostat, (*c*) two new forms of Balance,

(d) an attempt to produce a Spring Meter for Terrestrial Gravity —these were read at the University on the 20th January, 1886 ; (3) by Professor Blyth, M.A., " Direct-reading Galvanometer for Strong Currents," read before the Society on the 17th February.

All three communications were experimentally illustrated.

No Sectional Meetings have as yet been held.

The following gentlemen have been duly elected Associates of the Mathematical and Physical Section :—Mr. George A. Gibson, M.A., 3 Windsor Terrace ; Mr. Wm. Brown, Physical Laboratory, University ; Mr. W. H. Watkinson, 18 Willowbank Crescent ; Mr. W. Cleland, Woodhead, Coatbridge ; Mr. Wm. Wallace, 5 Radnor Terrace, Overnewton ; Mr. John Mack, 12 Glasgow Street, Hillhead ; Mr. John H. Macalpine, Greenlaw, Paisley ; Mr. Alex. Russell, 15 Kew Terrace ; Mr. Wm. Wyper, C.E., 7 Bowmont Gardens ; Mr. James Barrie Low, 17 Elgin Terrace, Dowanhill ; Mr. Alex. M'Lay, B.Sc., College of Science and Art.

(Signed) ROBERT FRANKLIN MUIRHEAD,
Secretary,
22 ARLINGTON STREET.

MINUTES OF SESSION.

4th November, 1885.

The Philosophical Society of Glasgow held its First Meeting for Session 1885-86, on the evening of the 4th November, 1885, at eight o'clock p.m., in the Rooms of the Society, 207 Bath Street—Dr. Henry Muirhead, President, in the Chair.

1. The Minutes of last Meeting of the Society were read,* and were approved and signed by the Chairman.

2. The following were proposed for the Membership of the Society:—

Mr. Gilbert Thomson, C.E., 75 St. George's Place. Recommended by Mr. W. R. M. Church, Professor M'Kendrick, and Mr. John Mann.

Mr. James Hackston Anderson, Cashier, Wardlawhill, Rutherglen. Recommended by Mr. William Gorman, Professor M'Kendrick, and Mr. John Mann.

3. Dr. Charles Cameron, M.P., read a paper on "Ferran's Anti-Cholera Inoculation." The paper excited considerable discussion, and Dr. Cameron was awarded a cordial vote of thanks.

At this period of the Meeting, the President being obliged to leave, Sir William Thomson, Honorary Vice-President, took the Chair.

4. Dr. M'Kendrick gave notice that, on behalf of the Council, he would move at next Meeting, "That in the Articles of Constitution of the Chemical, Biological, and Sanitary and Social Economy Sections, the following Rule be substituted for the one

* 29th April, 1885. See Vol. xvi., p. 379.

relating to the Annual Election of Office-bearers by the Section, viz.:—“The Office-bearers of the Section shall be elected by the Society at its Annual Business Meeting.”

5. Mr. John Mayer, F.C.S., moved the suspension of the standing orders, and this was unanimously agreed to.

6. Dr. Thomas Muir moved, and Mr. James Wood, M.A., seconded, “That steps be taken to reconstitute the Mathematical and Physical Section.” This was unanimously agreed to.

7. Dr. Thomas Muir moved, and Mr. James Wood, M.A., seconded, “That the following gentlemen be appointed as a Committee to draw up an amended Constitution and Rules for the Section, and to lay the same before the Society, with the names of the proposed Office-bearers, at next Meeting :—Dr. Henry Muirhead, President; Mr. Alexander Scott, Vice-President; Mr. J. J. Coleman, F.C.S.; Dr. M'Kendrick, Mr. Henry Dyer, M.A., C.E.; Mr. James T. Bottomley, M.A.; Dr. Thomas Muir, Mr. John Mayer, F.C.S.; Mr. James Wood, M.A.; Mr. Peter Alexander, M.A.; and Mr. R. F. Muirhead, B.Sc.,—Dr. M'Kendrick, Convener.”

8. The President announced that the following gentlemen had been duly elected Members of the Society:—

Mr. George M. Cruickshank, Patent Agent, 135 Buchanan Street. Recommended by Mr. Wallace Fairweather, C.E., Professor M'Kendrick, and Dr. Henry Muirhead.

Mr. F. O. Bower, M.A., F.L.S., Regius Professor of Botany in the University of Glasgow, 45 Kersland Terrace. Recommended by Professor Cleland, Professor M'Kendrick, and Dr. M'Gregor Robertson.

Mr. Alexander Eadie, Builder, 280 Cathcart Road. Recommended by Mr. Robert Scott, Mr. David Thomson, and Professor M'Kendrick.

Mr. Robert Fraser, 2 Crown Gardens, Dowanhill. Recommended by Mr. Jacques Van Raalte, Mr. James Thomson, and Professor M'Kendrick.

Mr. William Graham, Student in Arts, 195 Bath Street. Recommended by Mr. George Munsie, Mr. John B. Wingate, and Dr. Andrew Fergus.

Mr. Alexander B. Kirkpatrick, Stockbrokers, 88 St. Vincent Street. Recommended by Professor M'Kendrick, Mr. Andrew J. Kirkpatrick, and Dr. M'Gregor Robertson.

Dr. John Yule Mackay, Demonstrator of Anatomy in the University of Glasgow, 34 Elmbank Crescent. Recommended by Professor Cleland, Dr. M'Gregor Robertson, and Professor M'Kendrick.

Dr. George Miller, 1 Ibrox Terrace, Paisley Road. Recommended by Dr. Henry Muirhead, Dr. James B. Russell, and Professor M'Kendrick.

Mr. David Somerville, Engineer, 35 King Street. Recommended by Mr. James Connell, Mr. William Connell, and Mr. Robert Mitchell.

Mr. Archibald Walker, B.A., *Oxon.*, F.C.S., 8 Crown Terrace. Recommended by Mr. John B. Wingate, Mr. Robert MacBrayne, and Professor M'Kendrick.

Dr. R. Bruce Young, M.A., M.B., C.M., Demonstrator of Anatomy in the University of Glasgow. Recommended by Professor Cleland, Dr. M'Gregor Robertson, and Professor M'Kendrick.

Mr. Zachary M. H. Ross, M.A., Head English Master, Glasgow Academy. Recommended by Dr. W. Morrison, Professor M'Kendrick, and Dr. Henry Muirhead.

Mr. Alexander A. Cuthbert, Merchant, 14 Newton Terrace. Recommended by Professor M'Kendrick, Mr. Alexander Scott, and Dr. Henry Muirhead.

Mr. Edwin Gossman, Property Agent, 79 Robertson Street. Recommended by Mr. Adam Gossman, Mr. Daniel Wilson, and Mr. W. M. Ferguson.

Mr. John Laidlaw, 35 Hope Street. Recommended by Mr. Archibald Robertson, Dr. Henry Muirhead, and Professor M'Kendrick.

Mr. John Stevenson, C.E., 95 Bath Street. Recommended by Dr. Henry Muirhead, Mr. J. J. Coleman, and Professor M'Kendrick.

Mr. Walter Macfarlane, Ironfounder, 12 Lynedoch Crescent. Recommended by Dr. Henry Muirhead, Mr. J. J. Coleman, and Professor M'Kendrick.

Mr. Charles Clapperton, 16 Lilybank Gardens, Hillhead. Recommended by Mr. John Henderson, Jun., Mr. Alexander Rose, and Mr. A. P. Henderson.

Mr. Richard Miller, 54 St. Enoch Square. Recommended by Mr. Alexander Scott, Dr. Andrew Fergus, and Mr. Archibald Robertson.

Mr. D. M'Lachlan, 15 Hill Street, Garnethill. Recommended by Mr. Alexander Scott, Dr. Andrew Fergus, and Principal Jamieson.

Mr. Robert A. Whytlaw, 1 Windsor Quadrant, Kelvinside. Recommended by Mr. Gilbert Beith, Mr. Alexander Scott, and Dr. Andrew Fergus.

Mr. Alexander Petrie, I.A., Architect, 111 Bath Street. Recommended by George Smellie, Mr. John Mann, and Dr. M'Kendrick.

Mr. John Young, Chemist, Kincaid House, Milton of Campsie. Recommended by Professor M'Kendrick, Dr. Henry Muirhead, and Dr. M'Gregor Robertson.

Mr. John Turner, Clerk to the Barony Local Authority, 38 Cochrane Street. Recommended by Dr. M'Gregor Robertson, Professor M'Kendrick, and Dr. James Christie.

9. On the motion of Mr. John Mayer, F.C.S., Mr. John Thomson and Mr. Henry Dyer, M.A., were appointed Auditors of the Treasurer's Accounts for the past year.

(Signed) HENRY MUIRHEAD.

REPORT ON THE STATE OF THE SOCIETY BY THE COUNCIL
FOR SESSION, 1884-85.

I. *Meetings*.—The Society held 16 Meetings during the Session, which was opened on 5th November, 1884, and closed on 29th April, 1885. At these Meetings 31 papers were read, 21 of which appear in the *Proceedings*. There has been an increase over the previous year both of the papers read and of the number printed in the *Proceedings*, and it was found necessary to hold three extra meetings during the session to overtake the work. It is also worthy of notice that ladies were invited to several of the Meetings, and that they attended in considerable numbers.

II. *Membership*.—The number of Members on the Roll at the beginning of Session 1884-85 was 662; during the Session 47 new Members were elected; and 2 former Members were re-instated from the Suspense List, making 711; of these 26 have resigned, 8 have died, 2 have left Glasgow and

(*Report continued on page 417.*)

Dr.

ABSTRACT OF TREASURES

1885.—Oct. 31.

To Entry-money from 47 New Members, at £1a.	£49 7 0
.. Annual Dues from 3 Members for 1884-85, at £1a.	£3 0 0
.. Annual Dues from 540 Ordinary Members for 1884-85, at £1a.	£576 0 0
.. Annual Dues from 47 New Members for 1884-85, at £1a.	£49 7 0
	<u>£635 19 0</u>
.. Life subscription from 6 New Members at £10 10a.	£63 0 0
.. Life subscription from 4 Old Members at £10 10a.	£42 0 0
	<u>105 0 0</u>
	<u>£733 6 0</u>
.. Corporation of Glasgow, Interest on "Exhibition Fund" for year to Whitsunday, 1885—less Income Tax.	19 16 6
.. Bank Interest.	3 1 6
.. Proceedings, &c., sold.	0 11 6
.. ARCHITECTURAL SECTION— 33 Associates fees, at 5a.	13 5 0
.. CHEMICAL SECTION— 7 Associates for 1884-85, at 5a.	1 15 0
.. GEOGRAPHICAL AND ETHNOLOGICAL SECTION— 1 Associate fee for 1883-84, at 5a., . . .	£0 5 0
32 Do., for 1884-85, at 5a., . . .	8 0 0
	<u>8 5 0</u>
	<u>£832 0 6</u>

Memo. by Treasurer.—The Amount invested by the Society in the Bath Street Joint Buildings up to 31st October, 1885, is £3,547 8 1½ whereof, Paid from Society's Funds, £1,847 8 1½

Do. Private Loan, 200 0 0

Do. Society's half of
£3,000 Bond, 1,500 0 0

£3,547 8 1½

J. M.

ACCOUNT—SESSION 1884-85.

Cr.

1884.—Nov. 1.		
By Balance due Treasurer at end of last session,	. .	£27 11 6½
1885.—Oct. 31.		
,, Salary to Secretary,	£75 0 0	
,, Allowance for Treasurer's Clerks,	15 0 0	
,, Demonstrations at Lectures, and Lecturers' Travelling Expenses,	5 19 3	
		95 19 3
,, New Books, Periodicals, and Foreign Periodicals,	£114 15 8½	
,, Bookbinding,	22 15 6	
,, Printing Circulars, <i>Proceedings, &c.</i> ,	189 0 0	
,, Lithographs and Woodcuts for <i>Proceedings</i> ,	23 5 10	
,, Postage and delivery of Circulars, Letters, and Parcels,	43 11 4½	
,, Stationery,	8 19 0	
		402 7 5
,, Fire Insurance on Library for £5,400,	£5 18 0	
,, Postages, &c.—per Treasurer, £1 15s. 6d.; per Secretary, £7,	8 15 6	
,, Portraits, Frames, Repairs, &c.,	12 5 6	
,, Interest on Loans of £200 and £100,	13 10 0	
		40 9 0
,, Part Repayment of Floating Debt,	100 0 0	
,, SUBSCRIPTIONS TO SOCIETIES—		
Ray Society, 1885,	£1 1 0	
Paleontographical Society, 1885,	1 1 0	
		2 2 0
,, ARCHITECTURAL SECTION—		
Expenses per Treasurer of Section,		3 11 5
,, CHEMICAL SECTION—		
Expenses per Treasurer of Section,		0 11 0
,, GEOGRAPHICAL AND ETHNOLOGICAL SECTION—		
Expenses per Treasurer of Section,		11 13 6
,, SANITARY AND SOCIAL ECONOMY SECTION—		
Expenses per Treasurer of Section,		0 3 0
,, JOINT EXPENSES OF ROOMS—		
Society's half of £334 9s. 11d., being Interest on Bond, Insurance, Taxes, Cleaning, Lighting, and Heating; Salaries of Sub-Librarian and Assistant—less half of £47 17s. 6d. Revenue from Letting,	143 6 2½	
,, Balance in Treasurer's hands,	4 6 2	
		£832 0 6

GLASGOW, 10th November, 1885.—We, the Auditors appointed by the Society to examine the Treasurer's Accounts for the year 1884-85, have examined the same, of which the above is an Abstract, and have found them correct, the Balance due by the Treasurer at 31st October last being Four Pounds Six Shillings and Twopence.

(Signed) JOHN THOMSON.

HENRY DYER.

GRAHAM MEDAL AND LECTURE FUND.

ABSTRACT OF TREASURER'S ACCOUNT.—SESSION 1884-85.

£r.	£r.
EXPENDITURE—	
CASH AT 1ST NOVEMBER, 1884—	
Glasgow and South-Western Railway Co. 4% Preference Stock in name of the Philosophical Society, in Trust, Value of Die at H. M. Mint,	£250 0 0 18 18 0
Cash in Union Bank,	34 10 11
Cash in Treasurer's hands,	1 5 9
	<hr/> 35 16 8
REVENUE—	
Dividend, April 2, less Tax,	£4 17 3
" Oct. 1, "	4 17 0
Interest from Bank,	0 5 5
	<hr/> 9 19 8
CAPITAL AT 31ST OCT., 1885	
Investment,	£250 0 0
Dic,	18 18 0
Cash in Union Bank,	9 10 7
Cash in Treasurer's hands,	0 11 8
	<hr/> 10 2 3
<hr/> <hr/>	
	£314 14 4

£r.	£r.
EXPENDITURE—	
CASH AT 1ST NOVEMBER, 1884—	
Gold Medal, presented to Mr. E. C. C. Stanford,	£10 0 0
Outlays in connection with Transfer of Investment,	0 14 1
J. J. Coleman, as Editor of Dr. Angus Smith's "Life and Works of Thomas Graham," for Expenses of Publication, as per Account,	25 0 0
	<hr/> £35 14 1
CAPITAL AT 31ST OCT., 1885	
Investment,	£250 0 0
Dic,	18 18 0
Cash in Union Bank,	268 18 0
Cash in Treasurer's hands,	0 11 8
	<hr/> 268 18 0
<hr/> <hr/>	
	£314 14 4

WILLIAM WALLACE, *Treasurer.*

their names have been placed on the Suspense List, and 6 have been struck off the Roll for non-payment of annual subscription; leaving on the Roll at the beginning of the present Session 669 Members, being an increase of 7. Of the 47 new Members, 6 became Life Members; 4 Ordinary Members also paid the composition of Life Membership during the Session. During the year 3 Honorary Members were elected, namely, Louis Pasteur, Rev. John Kerr, LL.D., and Professor Asa Gray. Two vacancies exist in the list of Honorary Members. There are at present 18 Honorary Members, of whom 6 are Continental, 5 are American or Colonial, and 7 are British. The number of Corresponding Members is 11. The total number of Life Members is 73. The Membership of the Society then is as follows:—Honorary Members, 18; Corresponding Members, 11; Ordinary Members, 669; or a total of 698. It is interesting to note, as showing how rapidly the *personnel* of the Society changes, that of the 691 members whose names appear in the list of Members published in the *Proceedings* for 1884-85, only 316 were in the Society ten years ago. The esteemed President of the Geographical Section, Dr. Blackie, is the oldest Member of the Society—the year of his Membership being 1841. The following interesting table, prepared by Mr. Archibald Robertson, shows the number of Members now on the roll in relation to the year when they joined the Society:—

ORDINARY AND LIFE MEMBERS.

Underneath each year is shown the number of Members of that year who are still on the Roll of Membership.											Number of Members in successive decades still on the Roll.
1840	41	42	43	44	45	46	47	48	49		
0	1	0	4	1	2	3	3	4	1	=	19
1850	51	52	53	54	55	56	57	58	59		
7	4	1	3	2	9	12	3	2	4	=	47
1860	61	62	63	64	65	66	67	68	69		
10	3	4	7	5	3	6	7	9	57*	=	111
1870	71	72	73	74	75	76	77	78	79		
44	8	25	25	16	29	45	31	18	20	=	261
1880	81	82	83	84	85						
42†	57	24	54	36	18	6				=	231
TOTAL,											669

* Society removed from Andersonian University to Corporation Galleries—Nov., 1869.

† Society removed to 207 Bath Street—Nov., 1880.

Meetings, at which ten papers were read, and one of these, the address of the President, appears in the *Proceedings*.

(2). The *Chemical Section* held only two Meetings, chiefly of a business character, during the session; no sectional meetings for the reading of papers were held, but the President delivered an address before the Society, and also contributed a paper, both of which appear in the *Proceedings*. The small amount of work done by this section, compared with former years, is owing to the establishment in Glasgow of a branch of the Society of Chemical Industry in Great Britain, the effect of which has been to deprive the Philosophical Society of Chemical papers which otherwise would probably have been contributed to it. From one point of view this is to be regretted, as in former years the Chemists of Glasgow were amongst the most prominent supporters of the Philosophical Society, and their papers have enriched its *Proceedings*. It is to be hoped that Members of the Society engaged in Chemical research, whilst they support the new society with papers of a technical and practical character, will still give a share of their contributions to the Philosophical Society, more especially of papers relating to the theoretical aspects of the subject, and thus maintain the interest of Members in one of the most important branches of science.

The *Graham Medal* for 1884 was awarded to Mr. Edward C. C. Stanford, for his researches on the substance known as *Alglin*, discovered by him in sea-weeds. The Council has to report, with reference to the *Graham Medal Fund*, that Mr. J. J. Coleman, President of the Chemical Section, with the consent both of the Council of the Section and of the Trustees of the Fund, and as Treasurer of the Fund, has transferred to the Philosophical Society the sum of £250, being the Funds of the Trust, in order that the Society may act as Trustee for the Fund in place of the three Trustees who previously had charge of it. The Council, as representing the Society, has accepted of the Trust, and the money is now invested in the name of "The Philosophical Society of Glasgow, 207 Bath Street, Incorporated—in trust for the Thomas Graham Medal and Lecture Fund." This arrangement will secure the permanence of this Trust, whilst it enables the Society to encourage chemical research by carrying out the intentions of the Founders of the *Graham Medal*.

(3). *The Sanitary and Social Economy Section*.—This Section contributed to the ordinary meetings of the Society an address by the President and two papers, all of which have been printed in the *Proceedings*.

(4). *The Geographical and Ethnological Section*.—This Section contributed four papers to the ordinary meetings of the Society, one of which has been printed in the *Proceedings*. The continued interest in Geographical research is well shown by the fact that 44 Associates joined this Section during the session, and that through the liberality of Mr. James Stevenson and others a contribution was made to the fund for Explorations in New Guinea conducted by Mr. H. O. Forbes. The recent establishment of the Scottish Geographical Society has in no way impeded the operations of this Section, although that Society has a large number of members in Glasgow. With the view of co-operation, and thus of aiding in the diffusion of Geographical knowledge, the Council of the Society has

made an agreement with the Council of the Scottish Geographical Society, whereby Members of the Philosophical Society and Members of the Scottish Geographical Society will be admitted to all Meetings, either of the Philosophical Society or of the Scottish Geographical Society, at which Papers on Geographical subjects are read. Such Meetings will be duly notified to Members, who will thus have the opportunity of hearing all Papers or Lectures on Geographical subjects delivered in their rooms. It has also been arranged, for the present Session, with the kind consent of the Council of the Institution of Engineers and Shipbuilders, that the Meetings of the Scottish Geographical Society will be held in the Rooms of the Society.

IV. *Proceedings.*—The volume of *Proceedings* of the Society for 1884-5, Vol. XVI., contains 23 Papers, 6 Plates, and 2 Maps. The Society is again indebted to Mr. James Stevenson for the valuable Maps of Equatorial Africa and Senegambia. One of the best proofs of the value of the Papers contributed to the *Proceedings* is the number of applications for copies made from all parts of the world by those interested in the special subjects of the Papers. As pointed out in last Report, the Annual Volume is of great value as a medium of exchange, securing for the Library the Proceedings and Transactions of the more important Scientific Societies in the World.

V. *Finance.*—The Treasurer's Statement shows that during the past year the Floating Debt of the Society has been reduced from £300 to £200.

By order and on behalf of the Council.

(Signed) JOHN G. M'KENDRICK,
Secretary.

18th November, 1885.

The Philosophical Society of Glasgow held its Eighty-fourth Annual Meeting, on the evening of the 18th November, 1885, at eight o'clock p.m., in the Rooms of the Society, 207 Bath Street—Dr. Henry Muirhead, President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting were held as read, were approved, and were signed by the Chairman.

2. Mr. George M. Cruikshank, Mr. F. O. Bower, M.A., F.L.S., Mr. Alexander Eadie, Mr. Robert Fraser, Mr. William Graham, Mr. Alexander B. Kirkpatrick, Dr. John Yule Mackay, Dr. George Miller, Mr. David Somerville, Mr. Archibald Walker, B.A. *Oxon.*, F.C.S., Dr. R. Bruce Young, M.A., M.B., C.M., Mr. Zachary M. H. Ross, M.A., Mr. Alexander A. Cuthbert,

Mr. Edwin Gossman, Mr. John Laidlaw, Mr. John Stevenson, C.E., Mr. Walter Macfarlane, Mr. Charles Clapperton, Mr. Richard Miller, Mr. D. M'Lachlan, Mr. Robert A. Whytlaw, Mr. Alexander Petrie, I.A., Mr. John Young, and Mr. John Turner, were admitted to the Membership of the Society.

3. The following were proposed for the Membership of the Society:—

Mr. John Hamilton, I.A., Architect, 212 St. Vincent Street. Recommended by Mr. William Robertson Copland, M. Inst. C.E., Mr. John Mann, and Dr. Thomas Muir.

Mr. Robert Henderson, Timber Broker, 27 Union Street. Recommended by Mr. John McCrae, Mr. John Mayer, F.C.S., and Dr. M'Kendrick.

4. The Annual Report by the Council on the state of the Society having been printed in the Billet calling the Meeting, was held as read, and was unanimously adopted, and ordered to be printed in the *Proceedings*.

5. The audited Statement of Accounts for Session, 1884-85, by Mr. John Mann, Treasurer, having been printed in the Billet calling the Meeting, was held as read, was approved of, and was ordered to be printed in the *Proceedings*. The Treasurer also submitted an Inventory of the Furniture, &c., of the Society, which was ordered to be printed in the *Proceedings* for future reference.

6. In the unavoidable absence of Mr. John Robertson, Librarian and Convener of the Library Committee, Dr. M'Kendrick read the Annual Report on the Library, which was adopted, and ordered to be printed in the *Proceedings*. The Report was as follows:—

REPORT OF THE LIBRARY COMMITTEE.

Your Committee have pleasure in reporting that the Library has been taken advantage of by the Members, both for reading and reference, to a greater extent during the past year than in any previous one. 935 volumes were issued to 620 Members.

Since last Report 334 volumes, 75 parts of works, and 25 pamphlets have been added to the Library.

Of the periodicals received 24 are weekly, of which 19 are bought and 5 presented; 3 are fortnightly, of which 1 is bought and 2 presented; 42 are

monthly, of which 28 are bought and 14 presented; 25 are quarterly, of which 14 are bought and 11 presented.

Exchanges of *Transactions* and other publications are made with 136 Societies and Public Departments, from which 45 volumes and 56 parts of works have been received.

172 volumes and 3 parts were added to the Library by purchase. 107 volumes, 16 parts, and 25 pamphlets were presented, and the thanks of the Society are due to the donors.

Acknowledgment of the presentations made during Session 1884-5 will be found in volume xvi. of the *Proceedings*, where a complete list of the additions for that year and of the names of the Societies and Public Departments with which publications are exchanged has been printed.

During the year communication has been opened up, and exchanges effected with the Numismatic and Antiquarian Society of Philadelphia, the Manchester Geographical Society, the Hamburg Geographical Society, the Society for Psychical Research, the German Colonial League, Berlin, the Dutch Geographical Society, Amsterdam, the Editor of the *Mechanical World*, the Australasian Geographical Society, and the Royal Meteorological Society.

143 volumes have been bound, and 3 are in the hands of the binder.

The number of volumes in the Library is 9,511.

JOHN ROBERTSON, LIBRARIAN,
Convenor.

7. A vote of thanks was unanimously awarded to the Librarian, Treasurer, and Secretary for their services during the year.

8. The Society then proceeded to the election of Office-Bearers.

(1.) It was moved by Dr. J. B. Russell that Dr. James Morton be elected Vice-President of the Society for the next three years. The motion was carried by acclamation, and Dr. Morton accepted office.

(2.) The Chairman moved the re-election of Mr. John Robertson as Librarian, Mr. John Mann as Treasurer, and Professor M'Kendrick as Secretary, and these were unanimously re-elected to their respective offices.

(3.) It was moved by Dr. Morton, and seconded by Mr. A. Robertson, that Mr. Robert Franklin Muirhead, M.A., B.Sc., Professor William Dittmar, F.R.SS. L. and E., Mr. William Renny Watson, and Mr. James L. Mitchell, be elected to the four vacancies in the Council, caused by the retirement, in rotation, of Dr. Thomas Muir, Mr. E. M. Dixon, Dr. Morton, and Dr. Stirton. Mr. James Paton, F.L.S., Mr. Adam Knox, Dr. John Dougall,

and Mr. Henry Dyer, M.A., were also proposed and seconded. The Society then balloted for four Members of Council—Mr. George S. Buchanan and Mr. W. R. M. Church being appointed Scrutineers. The Scrutineers reported that the voting was as follows:—Professor Dittmar, 37; Mr. Renny Watson, 35; Mr. Muirhead, 35; and Mr. Mitchell, 28. These gentlemen were therefore declared by the Chairman to have been duly elected Members of Council for three years.

9. Dr. M'Kendrick, on behalf of the Council, moved, and Mr. J. J. Coleman seconded, “That in the Articles of Constitution of the Chemical, Biological, and Sanitary and Social Economy Sections, the following Rule be substituted for the one relating to the annual election of Office-Bearers by the Section, viz.:—*The Office-Bearers of the Section shall be elected by the Society at its Annual Business Meeting.*” Mr. James Thomson, F.G.S., moved the previous question, but, as no one seconded, the motion was carried, and the alteration made in the Constitution of the Sections specified.

10. Dr. M'Kendrick moved the election of Office-Bearers of the Biological Section for 1885-86, according to the list appended to this Minute. The motion was unanimously adopted, and the Office-Bearers elected.

11. Mr. J. J. Coleman, on behalf of the Chemical Section, moved the following alterations in the list of Office-Bearers of the Section. According to the Constitution of the Chemical Section four Members of Council retire, viz.:—Dr. John Clark, Mr. J. Snodgrass, Mr. J. B. Hannay, and Mr. W. J. Chrystal. Mr. Coleman moved that Dr. John Clark, Mr. W. J. Chrystal, Professor W. Dittmar, and Mr. W. Lang be elected to fill the vacancies—Dr. John Clark to be Vice-President, Dr. W. Wallace to be Treasurer, and Mr. John Mayer to be Secretary. The motion was unanimously adopted, and the Office-Bearers elected. The complete list of Office-Bearers of the Chemical Section for 1885-86 is appended to this Minute.

12. Sir Michael Connal, on behalf of the Sanitary and Social Economy Section, moved the election of Office-Bearers for the Section for 1885-86, according to the list hereto appended, the motion was unanimously adopted, and the Office-Bearers elected.

13. Dr. Thomas Muir, on behalf of the Geographical and Ethnological Section, moved the following alterations in the List of Office-Bearers of the Section :—That Messrs. James Grierson, Maxwell Hannay, William Ker, and Jacques van Raalte be re-elected Members of Council for the Geographical and Ethnological Section; that Messrs. Robert Gourlay and Arthur Kay be elected Members of Council for one year, in place of Messrs. John Steel and Walter Duncan; and that Dr. G. A. Turner be re-elected Secretary and Treasurer. The motion was unanimously adopted and the Office-Bearers elected. The complete List of Office-Bearers of the Section for 1885-86 is appended to this Minute.

14. Dr. M'Kendrick read the following Report of the Committee appointed at last Meeting, to draw up an amended Constitution and Rules for the proposed Mathematical and Physical Section, and to suggest the names of proposed Office-Bearers :—

1. Your Committee met on the 11th of November, present, Dr. Henry Muirhead, Mr. Alexander Scott, Dr. M'Kendrick, Mr. James T. Bottomley, Dr. Thomas Muir, Mr. James Wood, and Mr. R. F. Muirhead. Mr. Henry Dyer and Mr. Peter Alexander sent apologies for absence.

2. Your Committee recommended the adoption of the following Constitution for the Section :—

CONSTITUTION OF THE MATHEMATICAL AND PHYSICAL SECTION.

(1.) The object of the Section shall be to aid in the advancement of Mathematical and Physical Science, by affording opportunities for the discussion of subjects related thereto, to be introduced by the reading of papers or by verbal communications. The general aim shall be to have the papers read before the Society; but the Section may have separate meetings for that purpose, when in the opinion of the Council of the Section it is deemed desirable.

(2) The Section shall consist of Members of the Philosophical Society, who are to be admitted free to its meetings; and of Associates who are not Members of the Philosophical Society, who shall be admitted to the Section on payment of an annual subscription of five shillings. Associates to have the privilege of attending not only the Section's meetings, but also those meetings of the Society at which the Section's papers are read or discussed, and also of consulting the books in the library.

(3.) The management of the Section shall devolve upon a Council, consisting of a President, two Vice-Presidents, a Secretary (who shall also act as Treasurer), and nine other Members.

(4.) The term of office of Members of Council shall be three years, except in the case of the Secretary, who shall be elected annually. Retiring Members shall be eligible for re election. Three shall be a quorum.

(5.) The Office-Bearers of the Section shall be elected by the Society at its Annual Business Meeting.

(6.) Vacancies occurring during the currency of a year may be filled up, *ad interim*, by the Council of the Section if they deem it expedient.

(7.) The Council of the Section shall report annually to the Society.

(8.) No paper shall be read which has not been approved by the Council of the Section ; and copies of the paper read shall be given into the charge of the Secretary of the Society, or the Secretary of the Section, as the case may be.

(9.) Associates shall be elected by the Council at any of its meetings. Each candidate shall be recommended by two Members or Associates. The vote shall be by ballot, a majority deciding.

(10.) The Associates' Annual Subscription shall become due on the first day of November in each year.

(11.) No alteration shall be made upon the foregoing without the consent of the Society at two successive ordinary meetings.

3. Your Committee recommend the following as the first Office-Bearers of the Section :—Sir William Thomson, President; Dr. Thomas Muir and Professor Grant, Vice-Presidents; Mr. R. F. Muirhead, Secretary and Treasurer; and Mr. Peter Alexander, Professor Blyth, Mr. J. T. Bottomley, Mr. H. Dyer, Professor Jack, Principal Jamieson, Professor James Thomson, Mr. Renny Watson, and Mr. James Wood, Members of Council.

15. Dr. M'Kendrick moved the adoption of the Report, and also that the Section be formally instituted. This was seconded by Mr. ROBERT GOODWIN, and unanimously agreed to. The Mathematical and Physical Section was accordingly declared to be instituted.

16. Dr. M'Kendrick moved the election of the Office-Bearers of the Mathematical and Physical Section for 1885-86, named in the Report. This was unanimously agreed to, and the Office-Bearers were elected. The List is appended to this Minute.

17. Mr. Arthur Kay read a paper, entitled, "Notes on South Africa and the Africanders," for which he received the thanks of the Meeting.

18. Dr. G. A. Turner read a paper, entitled, "On the Verification of Traditions regarding the first peopling of certain Islands in the South Pacific," for which he received the thanks of the Meeting.

19. Dr. M'Kendrick's communication was postponed till next Meeting.

20. The following Gentlemen were declared to be duly elected into the Society :—

Mr. Frank M. Allan, Manufacturing Chemist, 6 Loudoun Terrace, Kelvinside. Recommended by Dr. John Clark, Dr. William Wallace, and Mr. Robert R. Tatlock.

Mr. James Hackston Anderson, Cashier, Wardlawhill, Rutherglen. Recommended by Mr. William Gorman, Professor M'Kendrick, and Dr. M'Gregor Robertson.

Mr. James C. Carter, Lecturer on Anatomy, Western Medical School, Hillhead. Recommended by Professor M'Kendrick, Dr. M'Vail, and Dr. William L. Reid.

Mr. John Craig, Stair Railer, 94 Paterson Street. Recommended by Mr. John Stewart, Mr. James Hunter, and Mr. John Sheriff.

Mr. Robert Ker Higginbotham, 10 Great Hamilton Street. Recommended by Mr. William Ker, Professor M'Kendrick, and Dr. M'Gregor Robertson.

Mr. Charles Ker, C.A., 1 Windsor Terrace, West. Recommended by Mr. William Ker, Professor M'Kendrick, and Dr. M'Gregor Robertson.

Mr. Gilbert Thomson, C.E., 75 St. George's Place. Recommended by Mr. W. R. M. Church, Professor M'Kendrick, and Dr. M'Gregor Robertson.

James Colville, M.A., D.Sc., 15 Newton Place. Recommended by Professor James Blyth, Dr. Thomas Muir, and Mr. William Milne, M.A.

Mr. John Mann, Jun., M.A., C.A., 154 St. Vincent Street. Recommended by Mr. Alexander Scott, Dr. Thomas Muir, and Dr. Henry Muirhead.

Mr. R. B. Macouat, 37 Elliot Street, Cranstonhill. Recommended by Mr. H. Wallace, Mr. Arthur Mechan, and Mr. John Steven.

Mr. William Howat, 37 Elliot Street, Cranstonhill. Recommended by Mr. H. Wallace, Mr. Arthur Mechan, and Mr. John Steven.

Mr. William L. Macindoe, M.A., LL.B., Writer, 32 Westbourne Gardens. Recommended by Mr. W. E. Wingate, Professor M'Kendrick, and Dr. M'Gregor Robertson.

AMENDED CONSTITUTION OF THE BIOLOGICAL SECTION.

(1.) The object of the Section shall be to aid in the advancement of Biological Science (including Anatomy, Physiology, Anthropology, Zoology, Botany, and Geology), by affording opportunities for the discussion of subjects related thereto, to be introduced by the reading of papers, or by verbal communications. The general aim shall be to have the papers read before the Society; but the Section may have separate Meetings for that purpose when, in the opinion of the Council of the Section, it is deemed desirable.

(2.) The Section shall consist of Members of the Philosophical Society, who are to be admitted free to its Meetings; and of Associates who are not Members of the Philosophical Society, who shall be admitted to the Section on payment of an Annual Subscription of five shillings. Associates to have the privilege of attending not only the Section Meetings, but also those Meetings of the Society at which the Section's papers are read or discussed, and also of consulting the books in the Library.

(3.) The Management of the Section shall devolve upon a Council, consisting of a President, two Vice-Presidents, a Secretary (who shall also act as Treasurer), and nine other Members.

(4.) The term of office of Members of Council shall be three years, except in the case of the Secretary, who shall be elected annually. Retiring Members shall be eligible for re-election. Three shall be a quorum.

(5.) The Office-Bearers of the Section shall be elected by the Society at its Annual Business Meeting.

(6.) Vacancies occurring during the currency of a year may be filled up, *ad interim*, by the Council of the Section, if they deem it expedient.

(7.) The Council of the Section shall report annually to the Society.

(8.) No paper shall be read which has not been approved of by the Council of the Section; and copies of the paper read shall be given into the charge of the Secretary of the Society, or the Secretary of the Section, as the case may be.

(9.) Associates shall be elected by the Council at any of its Meetings. Each Candidate shall be recommended by two Members or Associates. The vote shall be by ballot, a majority deciding.

(10.) The Associate's Annual Subscription shall become due on the first day of November, in each year.

(11.) No alteration shall be made upon the foregoing without the consent of the Society, at two successive ordinary Meetings.

(Signed) **HENRY MUIRHEAD.**

*2nd December, 1885. **

The Philosophical Society of Glasgow held its Second Ordinary Meeting, on the Evening of the 2nd December, 1885, at Eight o'clock p.m., in the Rooms of the Society, 207 Bath Street—Dr. Henry Muirhead, President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting were held as read, were approved, and were signed by the Chairman.

2. Mr. Frank M. Allan, Mr. James Hackston Anderson, Mr. James C. Carter, Mr. John Craig, Mr. Robert Ker Higginbotham, Mr. Charles Ker, C.A., Mr. Gilbert Thomson, C.E., Dr. James Colville, M.A., D.Sc., Mr. John Mann, Jun., M.A., C.A., Mr. R. B. Macouat, Mr. William Howat, Mr. William L. Macindoe, M.A., LL.B., were admitted to the Membership of the Society.

3. The following were proposed for election as Members of the Society, viz.:—

Mr. Robert Blyth, Accountant, 1 Montgomery Crescent. Recommended by Professor M'Kendrick, Mr. J. T. Bottomley, M.A., and Dr. M'Gregor Robertson.

Mr. William Landless, Architect, 227 West George Street. Recommended by Professor M'Kendrick, Mr. A. Lindsay Miller, and Mr. John Mann.

Rev. Albert Lazenby, 2 Regent Park Square. Recommended by Mr. W. Paton Buchan, Dr. Henry Muirhead, and Dr. John Barlow.

Dr. William Limont, Lecturer on Physiology, 328 Renfrew Street. Recommended by Principal M'Call, Dr. M'Gregor Robertson, and Professor M'Kendrick.

Mr. Magnus Maclean, M.A., Assistant, Physical Laboratory, University, 1 Lily Bank Place. Recommended by Sir William Thomson, Mr. J. T. Bottomley, and Professor M'Kendrick.

4. Professor M'Kendrick exhibited several microscopical specimens prepared by Dr. Loew, of Munich, showing the reducing action on salts of silver of vegetable protoplasm.

5. Professor M'Kendrick showed the production of rhythmic movement of the sartorius muscle of a frog by the action of Biedermann's fluid, consisting of common salt 5 grammes, alkaline sodium phosphate 2 grammes, and sodium carbonate 5 grammes, in a litre of water.

6. Mr. J. J. Coleman showed some experiments with a new form of galvanic battery devised by him, in which the metals used are copper and iron, and the fluids are solutions of sulphate of copper and sulphate of iron.

The thanks of the Meeting were accorded to Dr. M'Kendrick and Mr. Coleman for these experiments.

7. Mr. D. Sinclair, of the National Telephone Company, read a paper entitled "Telephonic Exchanges and how they are wrought," which was illustrated with instruments, diagrams, and communications with the Exchange system. Mr. Sinclair also exhibited several ingenious machines invented by him. He was awarded a cordial vote of thanks.

8. The President announced that Mr. John Hamilton and Mr. Robert Henderson had been duly elected Members of the Society.

(Signed) HENRY MUIRHEAD.

16th December, 1885.

The Philosophical Society of Glasgow held its Third Ordinary Meeting, on the evening of the 16th December, 1885, at eight o'clock p.m., in the Rooms of the Society, 207 Bath Street—Dr. Henry Muirhead, President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting were held as read, were approved, and were signed by the Chairman.

2. Mr. John Hamilton, I.A., and Mr. Robert Henderson were admitted to the Membership of the Society.

3. The following were proposed for the Membership of the Society :—

Mr. James Mavor, Drysalter, 134 St. Vincent Street. Recommended by R. F. Muirhead, M.A., Mr. J. T. Bottomley, M.A., and Professor M'Kendrick.

Dr. Alexander Napier, 3 Royal Crescent, Crosshill. Recommended by Professor M'Kendrick, Dr. M'Gregor Robertson, and Dr. Yule Mackay.

Mr. John Rennie, Physical Laboratory, University, 87 Park Road. Recommended by Sir William Thomson, Mr. J. T. Bottomley, and Professor M'Kendrick.

4. Mr. Alexander Buchan, M.A., F.R.S.E., Corresponding Member, and Secretary to the Scottish Meteorological Society, delivered an address on "The Rainfall of the British Islands," for which he was awarded a vote of thanks.

5. Mr. John Mayer, F.C.S., exhibited, and briefly described, a specimen of rich Cannel Coal and combined seam of Blackband Ironstone found a few days previously in the Bathgate district at a depth of about 170 fathoms, the boring having been done by diamond-boring machinery.

6. The President announced that Mr. Robert Blyth, Mr. William Landless, Rev. Albert Lazenby, Dr. William Limont, and Mr. Magnus Maclean, M.A., had been duly elected Members of the Society.

(Signed) HENRY MUIRHEAD.

6th January, 1886.

The Philosophical Society of Glasgow held its Fourth Ordinary Meeting, on the evening of the 6th January, 1886, at eight o'clock p.m., in the Rooms of the Society, 207 Bath Street—Dr. Henry Muirhead, President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting were held as read, were approved, and were signed by the Chairman.

2. Mr. Robert Blyth, Mr. William Landless, Rev. Albert Lazenby, Dr. William Limont, and Mr. Magnus Maclean were admitted to the Membership of the Society.

3. Professor Ferguson, M.A., read two papers:—(1) "On the First History of Chemistry;" and (2) "On some Early Treatises on Technological Chemistry." He was awarded a vote of thanks.

4. Mr. John Mayer, F.C.S., again exhibited and described the specimen of Cannel Coal shown by him at last Meeting. He was awarded a vote of thanks.

5. The President announced that Mr. James Mavor, Dr. Alexander Napier, and Mr. John Rennie had been duly elected Members of the Society.

(Signed) HENRY MUIRHEAD.

20th January, 1886.

The Philosophical Society of Glasgow held its Fifth Ordinary Meeting, on the Evening of the 20th January, 1886, at Eight o'clock p.m., in the Natural Philosophy Class-Room in the University of Glasgow—Dr. Henry Muirhead, President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting were held as read, were approved, and were signed by the Chairman.

2. The following gentleman was proposed for the Membership of the Society:—

Mr. John M'Gavin Macphail, Engineer, 4 Newhall Terrace, Greenhead. Recommended by Mr. J. J. Coleman, F.C.S., &c., Dr. M'Kendrick, and Dr. M'Gregor Robertson.

3. Mr. James Mavor, Dr. Alexander Napier, and Mr. John Rennie were admitted to the Membership of the Society.

4. Mr. James T. Bottomley gave an interesting description of modern methods of obtaining a Vacuum, exhibiting the arrangements of Dr. Andrews; the Mercurial Pumps of Bunsen and Lane Fox; the most improved form of the Sprengel Pump; and the Macleod Gauge for high Vacuums. He was awarded a cordial vote of thanks.

5. Sir William Thomson showed and described the following new instruments:—

- (1) New forms of Electric Measuring Instruments, including a Milliamperc Meter and an Ampere Meter.
- (2) New form of Wheatstone's Rheostat.
- (3) Two new forms of Balance.
- (4) An attempt to produce a Spring Meter for Terrestrial Gravity.

He received a hearty vote of thanks both for the communications, and also for having kindly invited the Society to hold the Meeting in the Natural Philosophy Class-Room.

(Signed) HENRY MUIRHEAD.

The Philosophical Society of Glasgow held an Extra Meeting, in conjunction with the Scottish Geographical Society, in the Rooms of the Society, 207 Bath Street, on the Evening of Wednesday, the 27th of January, 1886—Dr. W. G. Blackie, President of the Geographical and Ethnological Section, in the Chair.

1. Consul H. E. O'Neill, F.R.G.S., of Mozambique, read a paper on "The Ancient Civilization, Trade, and Commerce of Eastern Africa," for which he received a cordial vote of thanks.
2. Dr. Dudgeon, of Peking, read a paper on "China's Colonial Possessions," for which he received a hearty vote of thanks.

(Signed) W. G. BLACKIE.

4th February, 1886.

The Philosophical Society of Glasgow held its Sixth Ordinary Meeting, on the Evening of the 4th February, 1886, at Eight o'clock p.m., in the Rooms of the Society, 207 Bath Street—Dr. Henry Muirhead, President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting, were held as read, were approved, and were signed by the Chairman.
2. Professor Cleland, F.R.S., President of the Biological Section, read a paper on "Birds with Supernumerary Limbs, and the Principles of Double Monstrosity," for which he received a cordial vote of thanks. The paper was illustrated by diagrams and anatomical specimens.
3. Mr. James Paton, F.L.S., on behalf of Bailie Dickson and himself, read a paper on "The Museum Question in Glasgow." After some discussion, in which Professor M'Chesley, of Chicago, took part, the authors of the paper were awarded a cordial vote of thanks.
4. Mr. William Milne, M.A., B.Sc., communicated a paper on "The Defectiveness of the Eye-spot as a means of Generic Distinction in the *Philodinaria*, with a description of two other Rotifera." He received a cordial vote of thanks.

5. The President announced that Mr. John M'Gavin Macphail had been duly elected a Member of the Society.

(Signed) HENRY MUIRHEAD.

17th February, 1886.

The Philosophical Society of Glasgow held its Seventh Ordinary Meeting, on the Evening of the 17th of February, 1886, at Eight o'clock p.m., in the Rooms of the Society, 207 Bath Street—Dr. Henry Muirhead, President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting were held as read, were approved, and were signed by the Chairman.

2. Mr. Allan Stevenson, Architect, 42 New Market Street, Ayr, was proposed for the Membership of the Society by Mr. Robert J. Bennet, Mr. David Thomson, I.A., F.R.I.B.A., and Mr. William Gilfillan.

3. Mr. Joseph W. Swan, M.A., Inventor of the Swan Electric Lamp, and Corresponding Member, read a paper on an Electric Safety Lamp for the use of Miners, for which he received a vote of thanks. Specimens of the Lamp worked both by Primary and Secondary Batteries were shown, and one Lamp had, in addition, a Fire-damp Indicator.

4. Professor Ferguson, M.A., read a paper on John Beguinias, and his Chemical Writings, for which he received a vote of thanks.

5. Professor Blyth, M.A., described and exhibited a Direct-reading Galvanometer for strong currents, and also an ingenious Balance by which the strengths of currents as indicated by the repulsion of two neighbouring circuits could be estimated. He received a vote of thanks.

(Signed) HENRY MUIRHEAD.

3rd March, 1886.

The Philosophical Society of Glasgow held its Eighth Ordinary Meeting, on the Evening of the 3rd of March, 1886, at Eight o'clock p.m., in the Rooms of the Society, 207 Bath Street—Dr. Henry Muirhead, President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting were held as read, were approved, and were signed by the Chairman.

2. Dr. Thomas Barr read a paper on Inquiries on the effects of loud Sounds upon the Hearing of Boilermakers and others who work amid noisy surroundings, for which he received a vote of thanks.

3. Mr. George S. Buchanan read a Description of a New Mode of Signalling for Steamboat Piers or Railways, suggested to the Pilot Board as suitable for Firth of Clyde Steamers. He also showed a working Model of his invention. He received a vote of thanks.

4. Dr. John Glaister introduced to the Meeting three Queensland Aborigines (Billy, Jenny, and Little Toby), presently being exhibited in Glasgow by Mr. R. A. Cunningham, and he read a note on some of the Ethnological Characteristics of the race. Dr. Glaister received a vote of thanks.

5. The President announced that Mr. Allan Stevenson had been duly elected a Member of the Society.

(Signed) HENRY MUIRHEAD.

17th March, 1886.

The Philosophical Society of Glasgow held its Ninth Ordinary Meeting, on the evening of the 17th March, 1886, at eight o'clock p.m., in the Rooms of the Society, 207 Bath Street—Mr. Alexander Scott, Vice-President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting were held as read, were approved, and were signed by the Chairman.

2. James D. Marwick, Esq., LL.D., Town-Clerk of Glasgow, read a paper on "Observations on early Guilds of Merchants and Craftsmen, with special reference to the relations in which the Guilds of Scottish towns stand to those of other countries in bygone times." Dr. Marwick received a cordial vote of thanks.

3. Professor M-Kendrick introduced Mr. C. A. Sahlström of the Normal Company of Aberdeen, and read extracts from a paper prepared by Mr. Sahlström entitled "The Riches of the Sea." Mr. Sahlström then showed the Society samples of 55 different substances manufactured from Fish, Cetaceans, and Shell-fish by the Normal Company, including whale extract, whale fiorine, whale guano, whale oil, seal oil, fish glues, fish oils, extracts of whale and fish, and various preserved soups manufactured from fish. The Society had also the opportunity of tasting whale soup, fish extract soup, julienne soup, and pea soup, and fish sausages. Professor Cossar Ewart, of Edinburgh, and a member of the Fishery Board of Scotland, took part in the discussion, and described Mr. Sahlström's method of preserving fish by extracting their gases *in vacuo* and then forcing a weak solution of salt into the tissues with a pressure of seven atmospheres. Specimens of fish so preserved were exhibited. Mr. Sahlström was awarded a hearty vote of thanks.

(Signed) ALEX. SCOTT.

11th March, 1886.

A Joint-Meeting of the Philosophical Society of Glasgow and the Glasgow Branch of the Scottish Geographical Society was held on the evening of the 11th of March, 1886, at eight p.m., in the Rooms of the Society, 207 Bath Street—W. Renny Watson, Esq., President of the Glasgow Branch of the Scottish Geographical Society, in the Chair.

The Rev. W. Deans Cowan, F.R.G.S., &c., delivered a Lecture on "Travels in Eastern and Central Madagascar. The present condition and Commercial future of the Island." He was awarded a cordial vote of thanks.

(Signed) W. RENNY WATSON.

31st March, 1886.

The Philosophical Society of Glasgow held its Tenth Ordinary Meeting, on the evening of the 31st of March, 1886, at eight o'clock p.m., in the Rooms of the Society, 207 Bath Street—Mr. Alexander Scott, Vice-President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting were held as read, were approved, and were signed by the Chairman.

2. Mr. John Murray, Ph.D., Vice-President of the Royal Society of Edinburgh, and Director of the Office of the *Challenger* Expedition, read a paper on "The Physical and Biological conditions of the Seas and Estuaries about North Britain." The paper was illustrated by numerous diagrams and charts. Dr. Murray was awarded a cordial vote of thanks. In replying, Dr. Murray referred to the Marine Biological Station recently established at Cumbrae, and said that if the Society would build and maintain a suitable Laboratory in that district for the purpose of examining the Physical Conditions as to Temperature, &c., and the Marine Flora and Fauna, of the Firth of Clyde, he thought he could say, on behalf of those interested in the Station, that they would hand over to the Society the Yacht, Dredging Apparatus, and Plant, presently at the Marine Station referred to. Dr. Murray was thanked for the offer, and opinions were expressed that the work suggested would be very suitable for the Society.

3. Dr. Dougall showed specimens of material he had obtained from M. Pasteur, such as the spinal cord of a rabid rabbit, the inoculation matter of charbon, fowl cholera, &c., presently used by M. Pasteur, in his attempts to cure Hydrophobia by Inoculation. Dr. Dougall further showed several fine samples of the curare poison, and described its use by the natives of the district where it is found. He also read a short paper regarding the Etiology, Symptoms, Mortality and Pasteurian Treatment of Hydrophobia. He was awarded a vote of thanks.

4. The Chairman announced that Mr. Thomas Sutherland, Plumber, 112 Glebe Street (recommended by Dr. Glaister, Dr. M'Kendrick, and Dr. M'Gregor Robertson), had been duly elected a Member of the Society.

(Signed) ALEX. SCOTT.

14th April, 1886.

The Philosophical Society of Glasgow held its Eleventh Ordinary Meeting, on the evening of the 14th of April, 1886, at eight

o'clock p.m., in the Rooms of the Society, 207 Bath Street—Mr. Alexander Scott, Vice-President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting were held as read, were approved, and were signed by the Chairman.

2. Dr. John Glaister read a paper entitled—"On the Epidemic History of Glasgow for the last 100 years," for which he received a vote of thanks. The paper was contributed by the Sanitary and Social Economy Section.

3. Mr. J. Urie, Photographer, Jamaica Street, exhibited and described a new Automatic Photographic Printing Machine. He was awarded a vote of thanks.

(Signed) ALEXANDER SCOTT.

28th April, 1886.

The Philosophical Society of Glasgow held its Twelfth Ordinary Meeting, on the evening of the 28th April, of 1886, at eight o'clock p.m., in the Rooms of the Society, 207 Bath Street—Dr. Henry Muirhead, President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting were held as read, were approved, and were signed by the Chairman.

2. The following was proposed for election as Member of the Society, viz.:—

Mr. C. M. Aikman, M.A., B.Sc., F.C.S., Consulting Chemist, 183 St. Vincent Street. Recommended by Dr. McGregor Robertson, Dr. M'Kendrick, and Dr. Henry Muirhead.

3. Dr. Thomas Muir, on behalf of the Members of the Society, welcomed Dr. Muirhead back to the Chair after his recent illness, and offered their congratulations on his receiving from the University of Glasgow the Degree of Doctor of Laws.

4. Mr. Robert Blyth, C.A., read "Excerpt from Letter from the Hon. James Blyth, Secretary for Native Affairs in the Colony of Fiji, relating to the Tribe of Bequa's alleged power of walking through fire." The paper excited an interesting discussion, and

Mr. Blyth was awarded a vote of thanks. The paper was communicated from the Geographical and Ethnological Section.

5. Mr. Gilbert Thomson, M.A., C.E., Resident Engineer of the Glasgow Sanitary Protection Association, read a paper "On the relative merits of Tile and Cast-iron Drain Pipes," for which he was awarded a vote of thanks. The paper was communicated by the Sanitary and Social Economy Section.

6. Mr. J. B. Hannay, F.R.S.E., read a paper on "The Lucigen; a new industrial light." The apparatus for producing the light was exhibited and explained, and after the Meeting the Members saw it in operation in the lane behind the Society's Buildings. Mr. Hannay received the thanks of the Meeting for his very interesting communication.

12th May, 1886.

The Philosophical Society of Glasgow held its Thirteenth Ordinary Meeting, on the evening, of the 12th May, 1886, at eight o'clock p.m., in the Rooms of the Society, 207 Bath Street—Dr. Henry Muirhead, President, in the Chair.

1. The Minutes of last Meeting of the Society having been printed in the notice calling the Meeting were held as read, were approved, and were signed by the Chairman.

2. Dr. David Newman showed a man from whom he had recently removed the larynx, and who speaks with the aid of an artificial larynx, consisting of a vibrating free reed in a box or tube adapted to the throat. Professor M'Kendrick made some remarks as to the bearing of the case on the theory of vowel sounds, and demonstrated how the quality and apparent pitch of the vowels are influenced by the form and size of the resonant cavities above the vocal cords, or in this case above the vibrating reed. Dr. Newman was awarded a vote of thanks.

3. Dr. J. Yule Mackay, Senior Demonstrator of Anatomy, University of Glasgow, communicated the following anatomical papers :—

(1) On the Arteries of the Head and Neck, and the *rete mirabile* of the Porpoise (*Phocena communis*).

- (2) On the Arterial System of the Chameleon (*Chamaeleo vulgaris*).
- (3) Arrest of development of the Genito-urinary Organs.
- (4) Hermaphroditic malformation of the external Genital Organs in the female.

He was awarded a vote of thanks.

4. Dr. R. Bruce Young, M.A., Demonstrator of Anatomy, University of Glasgow, communicated the following anatomical papers :—

- (1) On the Homology of the Cervical Articular Pillars.
- (2) On the development of the Intestine.
- (3) On the Knee Joint.

He was awarded a vote of thanks.

All of the above papers were communicated from the Biological Section.

5. Professor M'Kendrick read the following address which it was proposed to send to M. Chevreul :—

To MICHAEL EUGÈNE CHEVREUL, Member of the Institute of France, &c., &c.

The Members of the Philosophical Society of Glasgow, of which you have been an Honorary Member since 1860, respectfully offer you their hearty congratulations on the near approach of your hundredth birthday. Your scientific labours since the beginning of the present century, and more especially your famous researches on the Chemistry of Fats, and on the Laws of Colour, as applied to the Arts, have made your name familiar as a household word, and the scientific workers of the present day not only regard you as an illustrious man of Science, but also as a living link with preceding generations of Chemists who have brought the science to its present position. They fervently hope that the evening of your days may be calm and peaceful, and that you may be solaced in thinking of the past, and of the many great men with whom you have been associated in the advancement of Science, whose names are now on the roll of fame, by the knowledge that your work also is of an enduring character, and that you have played an important part in the scientific achievements of the present century.

Signed, on behalf of the Philosophical Society of Glasgow, by

HENRY MUIRHEAD, *President.*

JOHN MANN, *Treasurer.*

JOHN G. M'KENDRICK, *Secretary.*

GLASGOW, May 12th, 1886.

It was moved by Dr. Morton, and seconded by Mr. John Mayer, F.C.S., that the Address be engrossed and forwarded without delay. This was carried unanimously, and the Secretary was instructed accordingly.

6. The President announced that Mr. C. M. Aikman had been duly elected a Member of the Society.

7. The Reports from the various Sections, on the motion of the Secretary, were held as read, and were ordered to be printed in the *Proceedings*.*

* This Minute will be signed by the Chairman, if approved, at the first Meeting of Session 1886-7.

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- Properties of Matter. By P. G. Tait. 8vo. London, 1885.
- Heat. By P. G. Tait. 8vo. London, 1884.
- Physical Expression. By F. Warner.
- Year Book of the Scientific and Learned Societies of Great Britain and Ireland. 8vo. London, 1885, 1886.
- Mineral Statistics of the United Kingdom for 1883-84. London, 1884.
- Commercial Organic Analysis. Vol. I. By A. H. Allen. 8vo. London, 1885.
- La Nature. 1st Part for 1885.
- Encyclopædia Britannica. Vols. XIX., XX. 4to. Edin., 1885.
- Records of the Rocks. By W. S. Symonds. 8vo. London, 1872.
- Encyclopædia of India. By Edward Balfour. 3 vols. 8vo. London, 1885.
- The Great Auk or Garefowl. By S. Grieve. 4to. London, 1885.
- Scientist's Directory. By S. E. Cassino. 8vo. Boston, 1885.
- The Congo and the Founding of its Free State. By Henry M. Stanley. 2 vols. 8vo. London, 1885.
- A Naturalist's Wanderings in the Eastern Archipelago. By Henry O. Forbes. 8vo. London, 1885.
- Work and Adventure in New Guinea, 1877-85. By J. Chalmers and W. W. Gill. 8vo. London, 1885.
- Life of Frank Buckland. By G. C. Bompas. 8vo. London, 1885.
- Anthropoid Apes. By R. Hartmann. 8vo. London, 1885.
- Die Lehre von der Electricität von G. Wiedemann. Band 4. 8vo. Braunschweig, 1885.
- Supplement to Spon's Dictionary of Engineering. 8vo. London, 1881.
- On Mammalian Descent. By W. K. Parker. 8vo. London, 1885.
- Manual of Geology—Theoretical and Practical. In two Parts. By John Phillips. Edited by Etheridge and Seely. 8vo. London, 1885.
- Select Methods in Chemical Analysis. By Prof. Crookes. 8vo. London, 1884.
- First Year of Scientific Knowledge. By Paul Bert. 12mo. London, 1885.
- Outlines of Psychology. By J. Sully. 8vo. London, 1885.
- Scottish Philosophy. By A. Seth. 8vo. Edinburgh, 1885.
- A History of Constitutional Reform in Great Britain and Ireland. By James Murdoch. 8vo. Glasgow, 1885.
- Charles Darwin. By Grant Allen. 8vo. London, 1886.
- The Kilima-njaro Expedition. By H. H. Johnston. 8vo. London, 1886.
- Story of the Heavens. By Ball. 8vo. London.
- Ecclesiastical Institutions. By Herbert Spencer. 8vo. London, 1885.
- The Races of Britain. By J. Beddoe. 8vo. Bristol, 1885.
- The Wanderings of Plants and Animals from their first Home. By Victor Hehn. 8vo. London, 1885.
- Osteology of the Mammalia. By W. H. Flower. 8vo. London, 1885.
- The First Three Years of Childhood. By B. Perez. 8vo. London, 1885.
- The Life of Sir Robert Christison, Bart. By his Son. 2 vols. Vol. I. Autobiography. 8vo. Edinburgh, 1885.

- A Treatise on Differential Equations. By A. R. Forsyth. 8vo. London, 1885.
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Marine Zoology. By P. H. Gosse. 2 vols. 12mo. London, 1855-6.
Life of Sir William Rowan Hamilton. By R. P. Graves. 2 vols. 8vo. Dublin, 1882.
Discussions on Climate and Cosmology. By J. Croll. 8vo. Edinburgh, 1885.
The Elements of Thermal Chemistry. By M. M. P. Muir and D. M. Wilson. 8vo. London. 1885.
Louis Pasteur—his Life and Labours. By his Son-in-law. 8vo. London, 1885.
Practical Bacteriology, based upon the Methods of Koch. By G. M. Crookshank. 8vo. London, 1886.
Micro-Organisms and Disease. By E. Klein. 8vo. London, 1885.
The Moon considered as a Planet, a World, and a Satellite. By J. Nasmyth and J. Carpenter. 8vo. London, 1885.
Comparative Literature. By H. M. Pasnett. 8vo. London, 1886.
The Law of Heredity—a Study of the cause of Variations and the Origin of Living Organisms. By W. K. Brooks. 8vo. Baltimore, 1886.
British Fungi. Hymenomycetes. By John Stevenson. 8vo. Edinburgh, 1886.

THE PHILOSOPHICAL SOCIETY EXCHANGES WITH THE
FOLLOWING SOCIETIES, &c.:—

Aberdeen Philosophical Society,	.	.	.	.	Aberdeen.
Academia Real Das Sciencias de Lisboa,	.	.	.	.	Lisbon.
Academy of Natural Sciences of Philadelphia,	.	.	.	.	Philadelphia.
Academy of Science,	.	.	.	.	Connecticut.
Academy of Science,	.	.	.	.	St. Louis.
American Academy of Arts and Sciences,	.	.	.	.	Boston.
American Geographical Society,	.	.	.	.	New York.
American Pharmaceutical Society,	.	.	.	.	Philadelphia.
American Philosophical Society,	.	.	.	.	"
Anthropological Institute,	.	.	.	.	London.
Astor Library, New York,	.	.	.	.	New York.
Library of Royal Observatory,	.	.	.	.	Melbourne.
Bath Natural History and Antiquarian Field Club,	.	.	.	.	Bath.
Belfast Natural History and Philosophical Society,	.	.	.	.	Belfast.
Berwickshire Naturalists' Club,	.	.	.	.	Alnwick.
Biblical Archaeology,	.	.	.	.	London.
Birkenhead Literary and Scientific Society,	.	.	.	.	Birkenhead.
Birmingham Philosophical Society,	.	.	.	.	Birmingham.
Boston Natural History Society,	.	.	.	.	Boston.
Boston Public Library,	.	.	.	.	"
Botanical Society of Edinburgh,	.	.	.	.	Edinburgh.
Bremen Geographical Society,	.	.	.	.	Bremen.
Bristol Naturalists' Society,	.	.	.	.	Bristol.
Buffalo Society of Natural Sciences,	.	.	.	.	Buffalo.

Bureau Scientifique Central Néerlandais,	Harlem.
California Academy of Sciences,	California.
Cambridge Philosophical Society,	Cambridge.
Canadian Institute,	Canada.
Cardiff Naturalists' Society,	Cardiff.
Chemical Society,	London.
Cleveland Institution of Engineers,	Middlesborough.
Commissioners of Patents,	London.
Davenport Academy of Natural Sciences,	Davenport, Iowa.
Deutscher Kolonial Verein,	Berlin.
Die Deutsche Chemische Gesellschaft,	"
Dublin University Biological Association,	Dublin.
École Polytechnique,	Paris.
Edinburgh Geological Society,	Edinburgh.
Engineering,	London.
Entomological Society of Ontario,	London, Ontario.
Epping Forest and County of Essex Naturalists' Field Club,	Buckhurst Hill, Essex.
Franklin Institute,	Philadelphia.
Geographical Society,	Geneva.
Geographical Society of Australasia,	Sydney.
Geographical Society of Scotland,	Edinburgh.
Geographische Gesellschaft zu Greifswald,	Greifswald.
Geological Society of Glasgow,	Glasgow.
Geological Survey of Canada,	Montreal.
Geological Survey of India,	Calcutta.
Glasgow Archaeological Society,	Glasgow.
Hamburg Geographical Society,	Hamburg.
Hertfordshire Natural History Society and Field Club,	Watford, Herts.
Historic Society of Lancashire and Cheshire,	Liverpool.
Institut Canadien-Français d'Ottawa,	Ottawa.
Institution of Civil Engineers,	London.
Institution of Engineers and Shipbuilders in Scotland,	Glasgow.
Institution of Mechanical Engineers,	Birmingham.
Institution of Mechanical Engineers,	London.
Insurance and Actuarial Society of Glasgow,	Glasgow.
Johns Hopkins University,	Baltimore.
Kasan Imperial University,	Kasan.
Kon. Akademie van Wetenschappen,	Amsterdam.
Leicester Literary and Philosophical Society,	Leicester.
Literary and Historical Society of Quebec,	Quebec.
Literary and Philosophical Society of Leeds,	Leeds.
Literary and Philosophical Society of Liverpool,	Liverpool.
Literary and Philosophical Society of Manchester,	Manchester.
Liverpool Engineering Society,	Liverpool.
Liverpool Geological Society,	"
Liverpool Naturalists' Field Club,	"
Liverpool Polytechnic Society,	"
London Geological Society,	London.

Manchester Association of Employers, Foremen, &c.,	Manchester.
Manchester Geographical Society,	"
Manchester Scientific Students' Association,	"
Manitoba Historical and Scientific Society,	Winnipeg.
Mechanical World,	London.
Meteorological Observatory,	Montsouris, Paris.
Middlesex Hospital,	London.
Midland Institute of Mining Engineers,	Barnsley.
Midland Medical Miscellany,	Leicester.
Mining Institute of Scotland,	Hamilton.
Mitchell Library,	Glasgow.
Musée Teyler,	Harlem.
National Academy,	Washington.
National Observatory,	"
Natural History Society of Glasgow,	Glasgow.
Naturalists' Union,	Huddersfield.
Netherlands Geographical Society,	Amsterdam.
New York Academy of Sciences,	New York.
New Zealand Institute,	Wellington.
North of England Institute of Mining Engineers,	Newcastle-on-Tyne.
N. Staffordshire Institute of Mining and Mechanical Engineers,	London.
Observatoire Royal de Bruxelles,	Bruxelles.
Odontological Society,	London.
Ohio Mechanics' Institute,	Cincinnati.
Oneida Historical Society,	Utica.
Paisley Public Library,	Paisley.
Pharmaceutical Society,	London.
Photographic Society,	"
Philadelphia Alumni Association,	Philadelphia.
Physical Society of London,	London.
Physico-Chemical Society, University of St. Peters- burg,	St. Petersburg.
Powys-land Club,	Liverpool.
Publisher of "Engineering,"	London.
Registrar-General,	Melbourne.
Royal Academy of Science,	Brussels.
Royal Academy of Science,	Stockholm.
Royal Astronomical Society,	London.
Royal Cornwall Polytechnic Society,	Falmouth.
Royal Dublin Society,	Dublin.
Royal Geographical Society,	London.
Royal Geographical Society,	Vienna.
Royal Institute of British Architects,	London.
Royal Institute of Lombardy,	Milan.
Royal Institution of Cornwall,	Truro.
Royal Institution of Great Britain,	London.
Royal Irish Academy,	Dublin.
Royal Microscopical Society,	London.

Royal Physical Society of Edinburgh,	.	.	.	Edinburgh.
Royal Prussian Academy of Science,	.	.	.	Berlin.
Royal Scottish Society of Arts,	.	.	.	Edinburgh.
Royal Society of Canada,	.	.	.	Quebec.
Royal Society of Edinburgh,	.	.	.	Edinburgh.
Royal Society of London,	.	.	.	London.
Royal Society of Tasmania,	.	.	.	Hobart Town.
Royal Society of Victoria,	.	.	.	Melbourne.
School of Mines,	.	.	.	New York.
Science,	.	.	.	Cambridge, Mass.
Science Monthly,	.	.	.	London.
Scottish Geographical Society,	.	.	.	Edinburgh.
Scottish Meteorological Society,	.	.	.	"
Seismological Society of Japan,	.	.	.	Tokio.
Smithsonian Institution,	.	.	.	Washington.
Social Science Association,	.	.	.	London.
Society for Psychical Research,	.	.	.	London.
Société des Sciences Physiques et Naturelles,	.	.	.	Bordeaux.
Société Royal des Sciences de Liége,	.	.	.	Liége.
Society of Arts,	.	.	.	London.
Society of Chemical Industry,	.	.	.	"
Society of Engineers,	.	.	.	"
South Wales Institute of Engineers,	.	.	.	Swansea.
Statistical Society,	.	.	.	London.
United States Geologist,	.	.	.	Washington.
United States Observatory,	.	.	.	"
United States Survey,	.	.	.	"
University of Christiania,	.	.	.	Christiania.
University of Tokio, Japan,	.	.	.	Tokio, Japan.
Verein für Erdkunde zu Halle,	.	.	.	Halle.
Videnskabs-Selskabet i Christiania,	.	.	.	Christiania.
Washburn Observatory—University of Wisconsin,	.	.	.	Washburn.
Wagner Free Institute of Science,	.	.	.	Philadelphia.

LIST OF PERIODICALS.

WEEKLY.

Academy.	Engineering.
Architect.	English Mechanic.
Atheneum.	Iron.
British Architect.	Journal of the Society of Arts.
British Medical Journal.	Journal of Gas Lighting.
Builder.	Mechanical World.
Building News.	Nature.
Chemical News.	Notes and Queries.
Comptes Rendus.	Pharmaceutical Journal.
Dingler's Polytechnisches Journal.	Science.
Electrician.	Scientific American.
Engineer.	Telegraphic Journal.

FORTNIGHTLY.

Berichte der Deutschen Chemischen Gesellschaft.	Bulletin de la Société Chimique de Paris. Journal für Praktische Chemie.
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MONTHLY.

American Journal of Science and Arts.	Annalen der Chemie.
Annales de Chimie et de Physique.	Annalen der Physik und Chemie.
Annales des Ponts et des Chaussées.	Annals and Magazine of Natural History.
Annales des Sciences Naturelles—Botanique.	Analyst.
Annales des Sciences Naturelles—Zoologie.	Antiquary.
Bulletin de la Société d'Encouragement.	Beiblätter zu den Annalen der Physik und Chemie.
Bulletin de la Société Géologique de France.	Journal of the Scottish Geographical Society.
Bulletin Mensuel de l'Observatoire de Montsouris.	London, Edinburgh, and Dublin Philosophical Magazine.
Canadian Entomologist.	Midland Medical Miscellany.
Chamber of Commerce Journal.	Midland Naturalist.
Chemische Industrie.	Monatsbericht der Königlich Preussischen Akademie der Wissenschaften zu Berlin.
Entomologist.	Odontological Society's Transactions.
Entomologists' Monthly Magazine.	Proceedings of Royal Society of London.
Geological Magazine.	Proceedings of Royal Geographical Society.
Hardwicke's Science Gossip.	Royal Astronomical Society's Monthly Notices.
Journal of the Franklin Institute.	Sanitary Journal.
Journal de Pharmacie et de Chimie.	Science Monthly.
Journal of Botany.	Zoologist.
Monthly Notes of the Library Association.	
Journal of the Photographic Society.	
Journal of Science.	
Journal of the Chemical Society.	

QUARTERLY.

Annales des Mines.	Quarterly Journal of Geological Society.
Bulletin de la Société Industrielle de Mulhouse.	Quarterly Journal of Microscopical Science.
Grevillea.	Quarterly Journal of Ornithology.
Journal of Anatomy and Physiology.	Quarterly Journal of Pure and Applied Mathematics.
Journal of the Royal Agricultural Society of England.	Revue Universelle des Mines.
Journal of the Scottish Meteorological Society.	Scientific Roll.
Journal of the Statistical Society.	Zeitschrift für Analytische Chemie.
Mind: a Quarterly Review of Psychology and Philosophy.	

LIST OF MEMBERS
OF THE
PHILOSOPHICAL SOCIETY OF GLASGOW,
FOR 1885-86.

HONORARY MEMBERS.

(*Limited to Twenty.*)

WITH YEAR OF ELECTION.

FOREIGN.

Michael Eugene Chevreul, Paris,	.	.	.	.	.	.	1860
Hermann Ludwig Ferdinand von Helmholtz, Berlin,	.	.	.	.	.	.	1860
Rudolph Albert Kölleker, Würzburg,	.	.	.	.	.	.	1860
Wilhelm Weber, Göttingen,	.	.	.	.	.	.	1860
Ernst Heinrich Haeckel, Jena,	.	.	.	.	.	.	1880
Louis Pasteur, Paris,	.	.	.	.	.	.	1885

AMERICAN AND COLONIAL.

James Dwight Dana, LL.D., Professor of Geology and Mineralogy in Yale College, Connecticut,	1860
Elias Loomis, Professor of Natural Philosophy, Yale College, Connecticut,	1860
Robert Lewis John Ellery, F.R.A.S., Victoria,	1874
10 Sir John William Dawson, LL.D., F.R.S., Principal of Macgill College, Montreal,	1883
Aaa Gray, LL.D., Professor of Natural History in Harvard University.	1885

BRITISH.

James Prescott Joule, LL.D., D.C.L., F.R.S., Manchester,	.	.	.	1860
Sir Andrew Crombie Ramsay, LL.D., F.R.S., London,	.	.	.	1874
Sir Joseph Dalton Hooker, K.C.B., K.C.S.I., M.D., D.C.L., LL.D., F.R.S., Kew,	.	.	.	1874
Thomas Henry Huxley, Ph.D., LL.D., D.C.L., P.R.S., London,	.	.	.	1876
Herbert Spencer, London,	.	.	.	1879
John Tyndall, LL.D., D.C.L., F.R.S., M.R.I., London,	.	.	.	1880
Rev. John Kerr, LL.D., Glasgow,	.	.	.	1885

CORRESPONDING MEMBERS.

WITH YEAR OF ELECTION.

Rev. H. W. Crosskey, LL.D., F.G.S., 117 Gough road, Birmingham,	1874
Robert Gray, F.R.S.E., Bank of Scotland, Edinburgh,	1874
A. S. Herschel, B.A., F.R.S., F.R.A.S., Professor of Physics, College of Science, 16 Saville row, Newcastle-on-Tyne,	1874
Thomas E. Thorpe, Ph.D., F.R.S., Professor of Chemistry in College of Science, Leeds,	1874
5 John Aitken, F.R.S.E., Darroch, Falkirk,	1883
Alex. Buchan, M.A., F.R.S.E., Secretary to the Scottish Meteorological Society, 73 Northumberland street, Edinburgh,	1883
James Dewar, M.A., F.R.S., L. & E., M.R.I., Jacksonian Professor of Physics, University of Cambridge, and Professor of Chemistry in the Royal Institution of Great Britain, Cambridge,	1883
Stevenson Macadam, Ph.D., F.R.S.E., Lecturer on Chemistry, Surgeons' Hall, Edinburgh,	1883
Joseph Swan, Newcastle-on-Tyne and London,	1883
10 E. A. Winsch, London,	1883
George Anderson, Master of the Mint, Melbourne,	1885

ORDINARY MEMBERS.

WITH YEAR OF ENTRY.

* Denotes Life Members.

Adam, William, M.A., 415 Sauchie-hall street.	1876	25 Barclay, James, 36 Windsor terrace. 1871
Addie, John, 144 St. Vincent street. 1861		Barclay, John, 37 Monteith row. 1882
Alexander, Peter, M.A., 16 Smith street, Hillhead. 1885		Barlow, John, M.D., Lecturer on Physiology in Royal Infirmary School, 27 Elmbank crescent. 1880
Alexander, Thos., 8 Sardinia terrace. 1869		Barnett, Hugh, Elmwood, Crosshill. 1883
5 Alley, Stephen, Edington, Langside. 1884		Baronsfeather, W. N., Rosebank, Manswood, Pollokshaws. 1880
Anderson, Alexander, 157 Trongate. 1869		30 Barrett, Francis Thornton, Mitchell Library. 1880
Anderson, David H., Atlantic Mills, Bridgeton. 1875		*Barr, James, 132 West Regent st. 1883
Anderson, James Jackson, Wardhill, Rutherglen. 1885		Barr, Thos., M.D., F.F.P. & S.G., 7 Albany place. 1879
Anderson, John, 22 Ann street. 1884		Bayne, A. Malloch, 1 Hamilton terrace, Partick. 1878
10 Anderson, J. T., 41 Westbourne gardens. 1881		Beaton, George T., B.A. Cantab., M.D., 2 Royal crescent. 1881
*Anderson, T. M'Call, M.D., Professor of Clinical Medicine in the University of Glasgow, 2 Woodside terrace. 1873		35 Begg, Wm., 636 Springfield road. 1883
Anderson, W. F. G., 47 Union street. 1878		*Beth, Gilbert, 7 Royal Bank Place. 1881
Arnot, James Craig, 162 St. Vincent street. 1869		Bell, Dugald, 27 Lansdowne crea. 1871
Arrol, Archibald, 16 Dixon street. 1869		*Bell, Henry, 5 Cornwall terrace, Regent's Park, London, N.W. 1876
15 Arrol, Walter, 16 Dixon street. 1869		Bell, James, 7 Marlborough terrace, Kelvinside. 1877
Arrol, William A., 16 Dixon street. 1869		40 Bell, Robt., M.D., F.F.P.S.G. and Ed., 29 Lynedoch street. 1869
Bain, Sir James, F.R.S.E., 3 Park ter. 1866		Bennett, Robert J., 8 Holland place. 1883
Bain, Robert, 132 West Nile street. 1869		Binnie, J., 69 Bath street. 1877
Baird, Alex. Smith, 26 Sardinia terrace, Hillhead. 1870		Binnie, Robert, Ashbourne, Gourock. 1881
20 Baldie, Robert, I.A., 83 Bath street. 1870		Black, Adam Elliot, C.A., F.C.S., 5 Hillsborough square, Bruce st., Hillhead. 1880
Ball, Henry W., Averley, Hillhead. 1875		45 Black, D. A., 214 Bath street. 1880
Balloch, Robert, 131 St. Vincent st. 1843		Black, D. Campbell, M.D., M.R.C.S.E., 50 Woodlands road. 1872
Balmain, Thos., 1 Kew terrace, Kelvinside. 1881		Black, J. Albert, 33 Lynedoch st. 1869
Barclay, Charles H., 28 Westbourne gardens. 1881		Black, John, 16 Park terrace. 1869

- Black, Malcolm, M.B., C.M., 5 Can-
ning place. 1880
- 50* Blackie, J. Alexander, 17 Stanhope
street. 1881
- * Blackie, J. Robertson, 17 Stanhope
street. 1881
- Blackie, Robert, 17 Stanhope st. 1847
- Blackie, W. G., Ph.D., F.R.G.S., 17
Stanhope street. 1841
- Blair, G. M'Lellan, 2 Lilybank
terrace. 1869
- 55 Blair, J. M'Lellan, 2 Bute Gardens,
Hillhead. 1869
- Blyth, James, M.A., F.R.S.E., Pro-
fessor of Mathematics and Natural
Philosophy in Anderson's College. 1881
- * Blyth, Robert, C.A., 1 Montgomerie
quadrant. 1885
- Bost, David Ashton, 60 New Sned-
don, Paisley. 1884
- Bost, Timothy, 33 Renfield street. 1876
- 60 Bottomley, James T., M.A., F.R.S.E.,
F.C.S., Demonstrator in Natural
Philosophy, University of Glas-
gow, 13 University gardens, Hill-
head. 1880
- Bottomley, Wm., Junr., C.E., Uni-
versity. 1880
- Boucher, J., I.A., 247 St. Vincent
street. 1870
- Bower, F. O., M.A., F.L.S., Regius
Professor of Botany in the Uni-
versity of Glasgow, 45 Kersland
terrace. 1885
- Bowie, Campbell T., 26 Bothwell
street. 1870
- 65 Boyd, John, Shettleston Iron Works,
near Glasgow. 1873
- Boyd, Rev. William, LL.D., 8
Windson terrace, west. 1885
- Brand, James, C.E., 172 Buchanan st. 1880
- Brodie, John Ewan, M.D., C.M.,
F.F.P.S.G., 1 Albany place. 1873
- Bromhead, Horatio K., I.A.,
A.R.I.B.A., 245 St. Vincent st. 1870
- 70 Brown, James, 76 St. Vincent st. 1876
- Brown, John, 22 Renfield street. 1879
- * Brown, John, 11 Somerset place. 1881
- Brown, John C., 149 West George
street. 1880
- Brown, Nicol, 34 Canonbury park,
London, N. 1869
- 75 Brown, Richard, Strone Colliery Co.,
49 W. George street. 1855
- Brown, Robert, 19 Jamaica street. 1882
- Brownlee, J., 23 Burnfield gardens. 1860
- Brownlie, Archibald, Bank of Scot-
land, Barrhead. 1880
- Brownlie, Jas., Victoria Saw Mills. 1877
- 80 Bruce, John Inglis, Helen st., Govan. 1869
- Brunton, Rev. Alex., Ardbeg villa,
Craigpark, Dennistoun. 1884
- * Bryce, Charles C., 141 West George
street. 1884
- Bryce, David, 129 Buchanan street. 1872
- Bryden, Robt. A., F.R.I.B.A., 15
Dalhousie street. 1870
- 85 Buchan, Thos., 249 Argyle street. 1883
- * Buchan, Wm. P., S.E., 21 Renfrew
street. 1875
- Buchanan, Alex. M., M.D.,
Professor of Anatomy in Ander-
son's College, 98 St. George's rd. 1876
- Buchanan, George, A.M., M.D.,
Professor of Clinical Surgery in
the University of Glasgow, 193
Bath street. 1875
- Buchanan, George S., 11 Ashton
terrace. 1845
- 90 Buchanan, William L., 212 St.
Vincent street. 1873
- Burnet, John, I.A., 167 St. Vincent
street. 1850
- Burnet, Lindsay, Assoc. M.I.C.E.,
St. Kilda, Dowanhill. 1882
- Burns, J., M.D., 15 Fitzroy place,
Sauchiehall street. 1864
- Burns, J. Cleland, Ferntower, Crieff. 1874
- 95 Cameron, Charles, M.D., LL.D.,
M.P., 104 Union street. 1870
- Cameron, H. C., M.D., 203 Bath
street. 1873
- Cameron, R., 123 St. Vincent st. 1873
- * Campbell, Sir A. C., Bart., M.P., of
Blythswood, Renfrew. 1885
- Campbell, J. A., LL.D., M.P., 137
Ingram street. 1848
- 100* Campbell, James, 137 Ingram st. 1885
- Campbell, John D., Merroughsdale
cottage, Copeland road, Govan. 1858
- Campbell, John MacNaught, Kelvin-
grove Museum. 1883
- * Campbell, Louis, 3 Eton terrace,
Hillhead. 1881
- Carlile, Thomas, 23 West Nile st. 1851
- 105 Carmichael, Neil, M.D., C.M., 29
S. Cumberland street. 1873
- Carmichael, Thomas, Mount Hope,
Bridge of Allan. 1879
- Carrick, John, I.A., City Architect,
74 Hutcheson street. 1846
- Carter, James C., Lecturer on Ana-
tomy, Western Medical School,
Hillhead. 1885
- Cassels, Robert, 168 St. Vincent
street. 1858
- 110 Chalmers, James, 113 West Regent
street. 1884
- Cherrie, James M., Clutha cottage,
Tollcross. 1876
- Christie, James, A.M., M.D.,
F.F.P.S.G., 2 Great Kelvin
terrace, Bank street, Hillhead. 1876

Christie, John, Turkey-red Works, Alexandria, Dumbartonshire.	1868	Crawford, W. B., 104 West Regent street.	1872
Chrystal, W. J., Shawfield Works, Rutherglen.	1880	Crawford, Wm. C., M.A., Lock- harton gardens, Slateford, Edin- burgh.	1869
115 Church, James, 88 Renfield street.	1867	150 Cree, Thomas S., 21 Exchange sq.	1869
Church, Wm., Jun., 75 St. George's place.	1855	Cruikshank, George M., 62 St. Vincent street.	1885
Church, W. R. M., C.A., 75 St. George's place.	1882	Cunningham, John M., Clydesdale Bank.	1881
Clapperton, Charles, 16 Lilybank gardens, Hillhead.	1885	Cunningham, J. R., Jun., Broom- field, Shandon, Gareloch.	1881
Clapperton, John, 5 Sandyford place.	1874	Curphay, Wm. Salvador, 268 Ren- frew street.	1883
120* Clark, G. W., Dumbreck house.	1877	155 Cuthbert, Alexander A., 14 Newton terrace.	1885
Clark, Henry E., L.R.C.S. Eng., 24 India street.	1876	*Cuthbertson, John N., 29 Bath st.	1850
Clark, John, Ph.D., F.I.C., F.C.S., 138 Bath street.	1870	Dansken, A. B., 179 West George street.	1877
Clark, John, 9 Wilton crescent.	1872	*Dansken, John, 121 West Regent street.	1876
*Clark, William, Mile-end.	1876	Darling, Geo. E., 178 St. Vincent street.	1870
125 Clavering, Thos., 30 Gordon street.	1856	160 Davidson, John, 96 St. Vincent st.	1885
Cleland, John, M.D., LL.D., D.Sc., F.R.S., Professor of Anatomy in the University of Glasgow.	1884	Day, St. John Vincent, C.E., F.R.S.E., 115 St. Vincent street.	1866
Clinkskill, James, 1 Holland place.	1868	Deas, Jas., C.E., 7 Crown gardens, Dowanhill.	1869
Clouston, Peter, 1 Park terrace.	1861	Dempster, John, Cambridge terrace, Albert Road, Pollokshields.	1875
Coats, Joseph, M.D., 31 Lynedoch street.	1873	Dennison, William, C.E., 175 Hope street.	1876
130* Cochran, Robert, 7 Crown circus, Dowanhill.	1877	165 Dewar, Duncan, St. Fillans, West Coates, Cambuslang.	1877
Coghill, Wm. C., 263 Argyle street.	1873	Dewar, Thos. Wright, 48 West Nile street.	1885
Coleman, J. J., F.I.C., F.C.S., F.R.S.E., Ardarrach, Bearsden.	1869	Dittmar, W., F.R.S., L. & E., Pro- fessor of Chemistry, Anderson's College.	1875
Collins, Sir William, 3 Park terracce, East.	1869	Dixon, A. Dow, 10 Montgomerie crescent, Kelvinside.	1873
Colquhoun, Jas., 158 St. Vincent street.	1876	Dixon, Edward M., B.Sc., 11 Hope- town place.	1860
135 Colville, James, M.A., D.Sc., 15 Newton place.	1885	170 Dobbie, A. B., M.A., University.	1885
Combe, William, 257 W. Campbell street.	1877	Donald, John, Dennistoun Public School.	1872
Connal, Sir Michael, Virginia build- ings.	1848	Donald, William J. A., 27 St. Vincent place.	1877
Connell, James, 182 Crookston st.	1870	Donald, Alex. W., Bank place, Cambuslang.	1880
Connell, Wm., 38 St. Enoch square.	1870	Dougall, Franc Gibb, 167 Canning st.	1875
140 Copeland, Jas., Dundonald road, Kelvinside.	1869	175 Dougall, John, M.D., C.M., F.F.P.S.G., Lecturer on Materia Medica, Royal Infirmary School of Medicine, 6 Belmar terrace, Pollokshields.	1876
Copland, Wm. R., M. Inst. C.E., 146 West Regent street.	1876	Douglas, Campbell, I.A., 266 St. Vincent street.	1870
Coubrough, A. Sykes, Blanefield, Strathblane.	1869	Downie, James, North Bank house, Kirkintilloch.	1872
Couper, James, Craigforth House, Stirling.	1862	Downie, R. M., 1 Dundas street.	1883
Cowan, M'Taggart, C.E., 27 Ashton terrace, Hillhead.	1876		
145 Craig, Alexander T., 264 St. Vincent street.	1884		
Craig, John, 94 Paterson street, Kingston.	1885		
Crawford, David, Jun., Glengowan Print Works, Caldercruix, by Airdrie.	1873		

- Downie, Robert, Jun., Carnutne
Dye-works, Parkhead. 1872
- 180 Drew, Alex., 149 West George st. 1869
- Dryburgh, Jas. N., Minerva cot-
tage, Holmhead, Cathcart. 1872
- Duncan, Eben., M.D., C.M.,
F.F.P.S.G., 4 Royal crescent,
Crosshill. 1873
- Duncan, Robert, Engineer, Partick
Foundry. 1875
- *Duncan, Walter, 9 Montgomerie
crescent. 1881
- 185 Dunlop, E. D., 68 St. Vincent st. 1883
- *Dunlop, Nathaniel, 1 Montgomerie
crescent, Great Western road. 1870
- Dunn, Robert Hunter, 4 Belmont
crescent. 1878
- Dyer, Henry, M.A., C.E., 8 High-
burgh terrace, Dowanhill. 1883
- Dyer, Rev. John Joseph, 10 Hill
street, Springburn. 1885
- 190 Eadie, Alexander, 280 Cathcart rd. 1885
- Easton, Walter, 125 Buchanan st. 1878
- Easton, William J., 150 West Regent
street. 1876
- Edwards, John, Govanhaugh Dye
Works. 1883
- Elder, James, C.E., 204 St. Vincent
street. 1881
- 195 Elgar, Francis, LL.D., "John Elder"
Professor of Naval Architecture
in the University of Glasgow. 1884
- Ewing Archibald, 21 West Nile st. 1883
- *Ewing, Wm., 7 Royal Bank place. 1883
- Fairlie, Colin B., C.E., 67 Renfield
street. 1874
- Fairweather, Wallace, C.E., 62 St.
Vincent street. 1880
- 200 Falconer, Patrick, 33 Hayburn cres-
cent, Partick. 1876
- Falconer, Thos., 50 Kelvingrove st. 1880
- Farquhar, John, 13 Belhaven terrace. 1872
- Fawsitt, Charles A., 4 Maule terrace,
Partick. 1879
- Fergus, Andrew, M.D., M.R.C.S.
Eng., 191 Bath street, Hon. Vice-
President. 1868
- 205 Fergus, Jas., 5 Burnbank gardens. 1880
- Ferguson, John, M.A., Professor of
Chemistry, University of Glasgow. 1869
- Ferguson, Peter, 4 Linwood ter.,
Glasgow st., Hillhead. 1866
- Ferguson, Thomas, Westmuir st.,
Parkhead. 1883
- Ferguson, William Muir, 116 St.
Vincent street. 1883
- 210 Ferguson, Alex. A., 48 M'Alpine st. 1847
- Fife, William, 52 Glassford street. 1880
- Finlay, Joseph, Clairmont, Winton
drive, Kelvinside. 1873
- Finlay, Robert Gilchrist, Jun.,
Holmfield, Dalmuir. 1881
- Finlayson, James, M.D., 351 Bath
street. 1873
- 215 *Fleming, James, 136 Glebe street. 1880
- *Fleming, William James, M.D., 155
Bath street. 1876
- Foulis, William, C.E., 42 Virginia
street. 1870
- *Fowler, John, Kelvinbank terrace,
Sandyford. 1880
- Frame, James, Union Bank of Scot-
land, 113 King street, Tradeston. 1885
- 220 Frame, Thomas, 40 Royal Exchange
square. 1863
- Fraser, Robert, 2 Crown gardens,
Dowanhill. 1885
- Frazer, Daniel, 127 Buchanan st. 1853
- Frew, Alex., C.E., 175 Hope street. 1876
- Gairdner, Charles, Broom, Newton-
Mearns. 1884
- 225 Gairdner, W. T., M.D., LL.D., Pro-
fessor of Practice of Medicine in
the University of Glasgow, 225 St.
Vincent street. 1863
- Gale, Jas. M., C.E., Water Office,
23 Miller street. 1856
- Galloway, T. Lindsay, C.E., 43 Mair
street, Plantation. 1881
- Gardner, Daniel, 36 Jamaica street. 1869
- *Garroway, John, 58 Buchanan st. 1875
- 230 Garroway, Robt., M.D., Rosemount,
Cumbernauld road. 1859
- Geddes, Wm., Battlefield, Langside. 1846
- Gibb, Peter, 10 Granby terrace. 1883
- Gillespie, Edward, Chapel Croft,
Cambuslang. 1882
- Gillies, Wm., Battlefield, Langside. 1869
- 235 Gillies, W. D., 2 Royal Exchange
court. 1872
- Gillilan, Wm., 129 St. Vincent st. 1881
- Glaister, John, M.B., 5 Grafton
place. 1879
- Goldie, James, 40 St. Enoch square. 1883
- Goodwin, Robert, 58 Renfield st. 1875
- 240 Gossman, Edwin, 79 Robertson st. 1885
- Gourlay, John, C.A., 24 George
square. 1874
- Gourlay, Robert, Kirklee avenue,
Great Western road. 1869
- Gow, Leonard, Jun., 19 Waterloo
street. 1884
- Gow, Robert, Cairndowan, Dowan-
hill gardens. 1860
- 245 Graham, David, Jun., 140 Douglas
street. 1876
- *Graham, William, 195 Bath street. 1885
- Grant, Robt., M.A., LL.D., F.R.S.,
Professor of Astronomy in the Uni-
versity of Glasgow, Observatory,
Hon. Vice-President. 1860

Gray, James, M.D., 15 Newton terrace.	1863	280 Hogg, Robert, Inglisby villa, Pollok-shields.	1865
Gray, James, 7 Knowe ter., Pollok-shields.	1876	Holt, T. G., 25 Wellington street.	1875
250 Greenlees, Alex., M.D., 33 Elm-bank street.	1864	Honeyman, John, F.R.L.B.A., 140 Bath street.	1870
*Grierson, James, 5 Belhaven cres., Kelvinside.	1880	Horne, R. R., C.E., 150 Hope street.	1876
Grieve, John, M.A., M.D., F.R.S.E., care of W. L. Buchanan, 212 St. Vincent st.	1856	Howat, William, 37 Elliot street.	1885
Guild, J. Wyllie, C.A., 17 Park terrace.	1884	285 Howatt, James, 146 Buchanan st.	1870
Haldane, T. Fred., Cartvale Chemical Works, Paisley.	1884	Howatt, William, 146 Buchanan street.	1870
255 Hamilton, Andrew, 2 Belmar terrace, Pollokshields.	1884	Hudson, John G., 18 Aytoun road, Pollokshields.	1883
Hamilton, Geo., 149 St. Vincent street.	1871	Hunt, Edmund, 87 St. Vincent street.	1856
Hamilton, John, I.A., 212 St. Vincent street.	1885	*Hunt, John, Milton of Campeie.	1881
Hamilton, Patrick, 149 St. Vincent street.	1854	290 Hunter, James, Newmains house, Motherwell.	1854
Hamilton, David C., 21 Carlton place.	1880	Hunter, James, 156 St. Vincent street.	1874
260 Hannay, Anthony, 23 Exchange square.	1856	Inglis, John, 64 Warroch street.	1850
Hannay, Jas. B., F.R.S.E., F.C.S., Annfield Chemical Works, Sword street.	1879	*Jack, William, M.A., LL.D., Professor of Mathematics in the University of Glasgow.	1881
Hannay, Maxwell, 104 West George street.	1881	Jamieson, Andrew, F.R.S.E., A.M.I.C.E., M.S.T.E., &c., Principal, College of Science and Arts.	1881
Hart, Arthur, 20 Woodlands terrace.	1883	Johnson, James Yate, C.E., 115 St. Vincent street.	1883
*Harvie, John, Secretary, Clydesdale Bank, 30 St. Vincent place.	1880	Johnstone, Jas., Coatbridge street, Port-Dundas.	1866
265 Henderson, A. P., 10 Crown terrace, Dowanhill.	1880	Kennedy, Hugh, Redclyffe, Partick.	1876
Henderson, George G., B.Sc., 1 Westbourne terrace.	1883	Kennedy, William, St. Margaret's, Newark Drive, Pollokshields.	1882
*Henderson, John, Jun., 4 Crown terrace, Dowanhill.	1879	Ker, Charles, C.A., 1 Windsor terrace, west.	1885
Henderson, Matthew, 4 Grant st.	1884	300* Ker, William, 1 Windsor terrace, West.	1874
Henderson, Robert, 27 Union st.	1885	Kerr, Charles James, Greenfaulds house, Cumbernauld.	1877
270 Henderson, Thos., 47 Union street.	1855	Kerr, James Hy., 13 Virginia st.	1872
Henderson, Wm., Ennerdale, Win-ton drive, Kelvinside.	1853	Kerr, John G., M.A., Garshake, Cambuslang.	1878
*Henderson, Wm., 15 Cadogan st.	1873	Key, William, Tradeston Gas-works.	1877
Henry, R. W., 8 Belhaven cres.	1875	305 King, James, 57 Hamilton drive, Hillhead.	1848
Heys, Zechariah J., South Arthurlie, Barhead.	1870	King, James, LL.D., of Levernholm, 115 Wellington street.	1855
275 Higinbotham, James S., Spring-field court, Queen street.	1874	Kirk, Alexander C., 19 Athole gar dens, Dowanhill.	1869
Higinbotham, Robert Ker, 10 Great Hamilton street.	1885	Kirk, Robert, M.D., Newton cottage, Partick.	1877
Higgins, Henry, Jun., 252 West George street.	1878	Kirkpatrick, Alexander B., 24 Berkeley terrace.	1885
Hodge, William, 27 Montgomery drive, Kelvinside.	1878	310 Kirkpatrick, Andrew J., 179 West George street.	1869
Hoey, David G., 196 St. Vincent street.	1869	Kirkwood, Anderson, LL.D., 7 Melville terrace, Stirling.	1869

- Kirsoe, John, 98 Argyle street. 1855
 Knox, Adam, 47 Crownpoint road. 1881
 Knox, John, 129 West George street. 1870
 315 Knox, John, 151 Renfrew street. 1883
 Laidlaw, John, 35 Hope street. 1885
 Laird, Geo., 10 Ann st., Bridgeton. 1870
 Laird, George H., 159 Greenhead street. 1882
 Laird, John, Marchmont, Port-Glasgow. 1876
 320 Laird, John, Royal Exchange Sale Rooms. 1879
 Lamb, Thomas, 220 Parliamentary road. 1870
 Landless, William, 227 West George street. 1885
 Lang, William, Jun., Crosspark, Partick. 1865
 Latta, James, 8 Miller street. 1869
 325 Latta, John, 138 W. George street. 1880
 Lazenby, Rev. Albert, 2 Regent Park square. 1885
 Lester, William, 2 Doune terrace, N. Woodside. 1884
 Lester, W. R., M.A.C.E., 2 Doune terrace, N. Woodside. 1884
 Limont, William, Lecturer on Physiology, 328 Renfrew street. 1885
 330 Lindsay, Archd. M., M.A., 87 West Regent street. 1872
 Lindsay, Charles C., C.E., 167 St. Vincent street. 1885
 Lindsay, Wm. G., 157 St. Vincent street. 1871
 Livingston, Robert, 263B Argyle street. 1879
 *Long, John Jex, 11 Doune terrace, Kelvinside. 1862
 335 Lothian, J. Alexander, M.D., L.R.C.S.E., 6 Newton terrace. 1872
 Low, James, 176 St. Vincent st. 1878
 M'Alley, Robert, Chemical Works, Falkirk. 1872
 M'Andrew, John, 17 Park street, East. 1843
 Macarthur, J. G., Glen Ogle, Kilmalcolm. 1874
 340 M'Call, J., F.R.C.V.S., Prof. of Veterinary Medicine and Surgery, Veterinary College, 85 Buccleuch street. 1866
 Maccall, Samuel, 16 Hillsborough square, Hillhead. 1882
 M'Callum, George, Rossbank, Cambuslang. 1850
 *M'Cllland, Andrew Simpson, C.A., 4 Crown gardens, Dowanhill. 1884
 M'Conville, John, M.D., 27 Newton place. 1870
 345 M'Crae, John, Baronald house, Maryhill. 1876
 M'Creath, James, M.E., 95 Bath street. 1874
 M'Culloch, William, 219 Victoria street, Hillhead. 1872
 M'Culloch, Hugh, 231 St. George's road. 1880
 Macdonald, Arch. G., 8 Park circus. 1869
 350*Macdonald, Thomas, 109 Bath street. 1869
 M'Ewen, Wm., Jun., 8 Park quadrant. 1869
 M'Farlane, Graham Jas., Elderslie. 1882
 Macfarlane, Samuel, Meadowbank, Torrance of Campsie. 1876
 M'Farlane, Walter, Printworks, Thornliebank. 1869
 355 Macfarlane, Walter, 12 Lynedoch crescent. 1885
 M'Gill, J. S., 8 Montgomerie quadrant. 1869
 M'Gillivray, James P., 112 Bath st. 1883
 *M'Gilvray, R. A., 129 West Regent street. 1880
 M'Gregor, Duncan, F.R.G.S., 37 Clyde place. 1867
 360 M'Gregor, James, 1 East India avenue, London, E.C. 1872
 M'Grigor, Alexander B., LL.D., 172 St. Vincent street. 1857
 M'Houl, David, Ph.D., Dalquhurn works, Kenton. 1883
 M'Ilwraith, James, 4 Westbourne terrace, Kelvinside. 1872
 Macindoe, William L., M.A., LL.B., 32 Westbourne gardens. 1885
 365 M'Intyre, Peter, 130 Ingram st., 34 Elmbank crescent. 1873
 Mackay, John Yule, M.B., C.M., 34 Elmbank crescent. 1885
 Mackay, John, Jun., 354 Sauchiehall street. 1869
 *M'Kenzie, W. D., 43 Howard street. 1875
 *M'Kenzie, W. J., 73 John street, City. 1879
 370* M'Kendrick, John G., M.D., C.M., LL.D., F.R.S., F.R.S.E., F.R.C.P.E., Professor of Institutes of Medicine in the University of Glasgow, 45 Westbourne gardens, Secretary. 1877
 Mackinlay, David, 6 Great Western terrace, Hillhead. 1855
 M'Kissack, John, 234 W. George street. 1881
 M'Lachlan, D., 15 Hill street, Garnethill. 1885
 Maclae, A. Crum, 147 St. Vincent street. 1884
 375 M'Laren, Robert, Canal street, Port-Eglinton. 1848

*Maclay, David T., 169 W. George street.	1879	*Miller, Arch. Russell, The Cairns, Cambuslang.	1884
Maclean, A. H., 8 Hughenden terrace, Kelvinside.	1870	*Miller, George, Winton drive, Kelvinside.	1881
Maclean, Magnus, M.A., 1 Lilybank place,	1885	Miller, George, M.D., 1 Ibrox ter., Paisley road.	1885
MacLehose, James J., M.A., 61 St. Vincent street.	1882	Miller, James, 21 Woodside place.	1869
380 M'Lellan, Lewis, 7 Belhaven ter.	1869	415 Miller, John (Messrs. James Black & Co.), 23 Royal Exchange sq.	1874
M'Lellan, Walter, 129 Trongate.	1856	Miller, Richard, 54 St. Enoch sq.	1885
Macmillan, Daniel, F.E.I.S., 26 Ashton terrace.	1882	Miller, Thomas, 30 Albert road, east	1876
M'Nab, John, 69 St. Vincent street.	1881	Miller, Thos., 138 Wellington st.	1882
M'Naughton, Duncan, Bearsden.	1883	*Miller, Thos. P., Cambuslang Dye-works.	1864
385 M'Nicol, Peter, M.A., 14 Derby terrace.	1873	420 Miller, W. M., 7 Mansfield place, West Regent street.	1867
Macouat, B. R., 37 Elliot street	1885	Milligan, W. J., 2 Hamilton ter., Partick.	1881
Macphail, Donald, M.D., Garturk cottage, Whifflet, Coatbridge.	1877	Mills, Edmund J., D.Sc., F.R.S., Anderson's College.	1875
Macphail, John M'Gavin, 4 New-hall terrace, Greenhead.	1886	Milne, William, M.A., B.Sc., F.R.S.E., High School.	1881
M'Pherson, George L., 26 Albert road, Crosshill.	1872	Mirrlees, James B., Redlands, Kelvinside.	1869
390 M'Vail, D. C., M.B., 3 St. James' terrace, Hillhead.	1873	425 Mitchell, George A., 67 West Nile st.	1883
Maddever, John C., Sen., M.D., 19 Battery place, Rothesay.	1881	Mitchell, Jas. L., 10 Gt. Western terrace.	1878
Main, James A. R., 54 Gordon street.	1870	Mitchell, Robert, 12 Wilson street, Hillhead.	1870
Main, Robert B., 6 Maxwell ter., Pollokshields.	1885	*Moffatt, Alexander, 47 Union st.	1874
Manford, Stuart, 18 St. James' ter., Hillhead.	1874	*Monteith, Robert, Greenbank, Dowanhill gardens.	1885
395 Mann, John, C.A., 188 St. Vincent street, Treasurer.	1856	430 Montereau, Emile Louis de, 61 Renfield street.	1877
Mann, John, Jun., M.A., C.A., 188 St. Vincent street.	1885	Montgomerie, James, 18 Bishop street, Port-Dundas.	1884
Manwell, James, The Hut, 4 Albert road, Pollokshields.	1876	Moore, Alexander, C.A., 209 West George street.	1869
Marwick, J. D., LL.D., F.R.S.E., Killermont House, Maryhill.	1878	Morgan, John, Springfield house, Bishopbriggs.	1844
Marks, Samuel, Jeanette villa, Tollcross.	1884	Morrice, Alexander, Tullymet, Aytoun road, Pollokshields.	1873
400 *Mason, Stephen, M.P., 24 Belhaven terrace.	1870	435 Morrice, Jas. A., Tullymet, Aytoun road, Pollokshields.	1883
Mathieson, Thomas A., 13 East Campbell street.	1869	Morison, William, 10 Franklin ter.	1885
Mavor, James, 134 St. Vincent st.	1885	Morrison, Donald, LL.D., 4 Victoria terrace, Dowanhill.	1877
Mayer, John, F.C.S., 2 Clarinda terrace, Pollokshields.	1860	Morrison, James, 98 Sauchiehall street.	1869
Mechan, Arthur, 36 Elliot street.	1876	Morrison, Thomas, M.A., LL.D., 2 Eldon terrace, Partick.	1884
405 Mechan, Henry, 36 Elliot street.	1879	440 Morton, James, M.D., Professor of Materia Medica in Anderson's College, 199 Bath street.	1868
Menzies, Thos., Hutcheson's Grammar School, Crown street.	1859	Mossman, John, 6 Queen's terrace, west.	1870
Michaelson, M., 5 Woodside place.	1878	Muir, Alex., 65 Eglinton street.	1883
Middleton, Robert T., 179 West George street.	1860	Muir, Alex. G., 37 Victoria road, Crosshill.	1882
Millar, James, 158 Parliamentary road.	1870	*Muir, Allan, 36 George street.	1881
410 Miller, A. Lindsay, 121 W. Regent street.	1878	445 Muir, John, 6 Park gardens.	1876

Muir, T., M.A., LL.D., F.R.S.E., Beechcroft, Bishopston.	1874	Park, James, Millburn Chemical Works.	1877
Muir, Wm., Lintmill Bleachworks, Neilston.	1882	*Parnie, James, 32 Lynedoch street.	1874
Muir, William R., 7 Kelvingrove terrace.	1877	480 Paterson, Jas. A., 27 Apaley place.	1882
*Muirhead, Andrew Erskine, Cart Forge, Crossmyloof.	1873	*Paterson, Robert, C.A., 28 Renfield street.	1881
450 *Muirhead, Henry, M.D., LL.D., F.F.P.S.G., Bushy Hill, Cambuslang, President.	1866	Paterson, Robert Baird, 180 Tron-gate.	1883
*Muirhead, Robert F., M.A., B.Sc., c/o Miss Leck, 22 Arlington st.	1879	Paton, Jas., F.L.S., Corporation Galleries, and Kelvingrove Museum.	1876
Munro, Daniel, 22 Burnbank ter.	1867	Paton, Wm. Grant, 11 Kersland terrace, Hillhead.	1883
Munsie, George, 1 St. John's ter., Hillhead.	1871	485 Patterson, T. L., F.C.S., at John Walker & Co.'s, Greenock.	1873
Munsie, Robert George, 10 Berkeley terrace, west.	1883	Pearce, William, M.P., 10 Park terrace.	1881
455 Murdoch, James, Glenneuk, Port-Glasgow.	1857	Petrie, Alexander, I.A., 111 Bath street.	1885
Murdoch, Jas. B., Hamilton place, Langside.	1855	Pirie, John, M.D., 26 Elmbank crescent.	1877
Murdoch, Robert, 10 King st., S.S.	1880	*Pirie, Robert, 9 Buckingham ter.	1875
Murdoch, Wm., 20 Carlton place.	1879	490 Pollock, Arthur, Dillichip Works, Alexandria.	1879
*Murray, David, 169 West George street.	1876	*Pollock, R., M.B., C.M., F.F.P. & S.G., Laurieston house, Pollokshields	1883
460 Murray, A. Erskine, Sheriff-Substitute of Lanarkshire, Sundown, Montgomerie drive.	1881	Poynter, John E., 72 Great Clyde street.	1866
Napier, Alex., M.D., F.F.P.S.G., 3 Royal crescent, Crosshill	1886	Price, Rees, L.D.S.Eng., 147 Bath street.	1883
Napier, James, Jun., 10 Carment drive, Shawlands.	1870	*Provan, James, 40 West Nile st.	1868
*Napier, John, 23 Portman square, London.	1849	495 Raalte, Jacques Van, 136 West Regent street.	1884
Neilson, Walter M., Queenshill, Ringford, Kirkcudbrightshire.	1843	Ramsay, John, of Kildalton, M.P., 5 Dixon street.	1856
465 Nelson, Alex., 8 Prince's square.	1880	Ramsay, Robert, M.D., L.R.C.S.E., Lochwinnnoch.	1881
Nelson, D. M., 164 St. Vincent st.	1875	Rankine, David, C.E., 75 West Nile street.	1875
*Newlands, Joseph F., 28 Renfield street.	1883	Rankine, Captain John, 31 Airlie terrace, Pollokshields.	1869
Newman, David, M.D., C.M., Pathologist, Royal Infirmary, 18 Wood-side place, W.	1877	500 Rattray, Rev. Alex., M.A., Park-head parish, 4 Westercraig, Dennistoun.	1879
Nicol, James, City Chambers,	1872	Reid, Andrew, 20 North Albion street.	1875
470 Nicholson, Alex., Jun., 6 Annfield place, Dennistoun.	1883	*Reid, Hugh, 10 Woodside terrace.	1880
Niven, Thos. O., C.E., 131 West Regent street.	1884	Reid, James, 10 Woodside terrace.	1870
Nowery, William, 37 Derby street.	1876	Reid, J. G., 9 St. Vincent place.	1874
Ogilvie, William, 1 Doune terrace.	1881	505 Reid, Thos., M.D., 11 Elmbank st.	1869
Osborne, Alex., 5 Oakley terrace, Dennistoun.	1870	Reid, William, M.A., High School.	1881
475 Outram, D. E., 16 Grosvenor ter., Hillhead.	1878	*Reid, William L., M.D., 7 Royal crescent, west.	1882
Paris, Wm., Glasgow Iron Works, St. Rollox.	1859	Reith, Rev. George, M.A., Free College Church, 38 Lynedoch st.	1876
Paris, William, Jun., Glasgow Iron Works.	1859	Remmers, B. H., 189 St. Vincent st.	1880
		510 Rennie, John, 87 Park road.	1886
		Renton, James Crawford, M.D., L.R.C.P.&S.Ed., 2 Buckingham terrace.	1875
		Ritchie, R. Brown, 79 West Regent street.	1883

	Ritchie, Wm., Jun., Waltry, Milton of Campsie. 1870	Scott, James, 6 Wilton crescent. 1869
	Robertson, Archibald, 25 Queen street. 1863	Scott, Robt., 115 Wellington street. 1884
515	Robertson, Archibald, 12 Hope street. 1867	Seligmann, Hermann L., 27 St. Vincent place. 1850
	Robertson, Archibald, Ballan- clerch, Lennoxtown. 1884	Sellars, Jas., I.A., 266 St. Vincent street. 1873
	Robertson, James, 21 Afton cres. 1865	Shaw, John M., 14 Union street. 1880
	Robertson, Rev. James, D.D., Pro- fessor of Oriental Languages in the University of Glasgow. 1884	Sheriff, John, 156 St. Vincent st. 1876
	Robertson, John, 10 Valeview ter., Langside, <i>Librarian</i> . 1860	Shirreffs, W., 249 W. George street. 1884
520	Robertson, J. Anderson, M.A. (Oxon.), 2 Cathedral street. 1882	Sim, William, 3 Royal crescent. 1862
	Robertson, J. M'Gregor, M.A., M.B., Muirhead Demonstrator of Physiology, University. 1881	Simons, Michael, 206 Bath street. 1880
	Robertson, Rev. F. L., D.D., 204 Bath street. 1883	Simpson, P. A., M.A. Cantab., M.D., Regius Professor of Forensic Medi- cine, University, 1 Blythswood sq. 1881
	Robertson, Robert, 41 So. Cumber- land street. 1877	Sinclair, Alexander, Ajmere lodge, Langside. 1883
	Robertson, Robert A., Nenthorne, 42 Ayton road, Pollokshields. 1877	Sinclair, D., National Telephone Co., Limited, 8a Royal Exchange buildings. 1883
525	Robertson, William, C.E., 123 St. Vincent street. 1869	Sloan, Samuel, M.D., 1 Newton terrace. 1877
	Robertson, Wm., Wellpark Brewery. 1876	Smart, Robt., M.D., 4 Queen's cres. 1873
	Robson, Hazelton R., 14 Royal crescent, west. 1876	Smellie, George, 167 St. Vincent street. 1880
	Rose, Alexander, 18 Huntly gardens, Dowanhill. 1879	*Smellie, Thos. D., 209 St. Vincent street. 1871
	Ross, Henry, 7 Park quadrant. 1876	Smillie, R. D., M.S.T.E. and E., Messrs. Wm. Denny & Brothers, Dumbarton. 1883
530	*Ross, John, 9 Westbourne gar- dens. 1885	Smith, Francis, 45 Gordon street. 1875
	Ross, Zachary M. H., M.A., Glas- gow Academy. 1885	Smith, Geo., Sun Foundry, Kennedy street. 1870
	Rottenburg, Paul, 21 St. Vincent pl. 1872	Smith, Harry J., Ph.D., 27 Buck- ingham terrace. 1877
	Rowan, David, 22 Woodside place. 1863	Smith, Hugh C., 55 Bath street. 1861
	Rowan, Frederick J., C.E., 134 St. Vincent street. 1882	Smith, James, 20 Park terrace. 1881
535	Rowan, W. G., 234 West George street. 1881	*Smith, J. Guthrie, 54 West Nile street. 1875
	Rundell, R. Cooper, Underwriters' Room, Royal Exchange. 1877	*Smith, Robert B., Underwood, by Denny. 1884
	Russell, James B., B.A., M.D., 1 Montrose street, Vice-President. 1862	Smith, W. R. W., 6 S. Hanover st. 1868
	Russell, Thomas, Cleveden, Kelvin- side gardens. 1870	Snodgrass, James, F.C.S., Walkin- shaw Oil Works, near Paisley. 1877
	Salmon, James, F.R.I.B.A., 197 St. Vincent street. 1870	Somerville, David, 35 King street, S.S. 1885
540	Salmon, W. Forrest, F.R.I.B.A., 197 St. Vincent street. 1870	Sorley, Robert, 3 Buchanan st. 1878
	Sandeman, D., Woodlands, Lenzie. 1870	Spence, John W., Athelstane, Helensburgh. 1881
	Schmidt, Alfred, 382 New City road. 1881	Spens, John A., 169 W. George street. 1879
	Scott, Alex., 2 Lawrence place, Dowanhill, Vice-President. 1871	Spiers, John, 43 Great Western road, Hillhead. 1885
	Scott, Arthur T., M.A., 4 Dixon street. 1882	Stanford, Edward C. C., F.C.S., Glenwood, Dalmuir, Dumbarton- shire. 1864
545	*Scott, D. M'Laren, Carberry villa, Tollcross. 1881	Steel, James, 46 Grafton street. 1870
		*Stephen, John, Domira, Partick. 1880
		Stephen, Robt. R., Adelphi Biscuit Factory. 1867
		*Steven, Hugh, Westmount, Mont- gomerie drive. 1869
		Steven, John, 32 Elliot street. 1875

	Stevenson, Allan, 42 New Market street, Ayr.	1886	Thomson, Graham Hardie, 10 Dounre terrace, North Woodside.	1869
*585	*Stevenson, Jas., 23 West Nile street.	1870	Thomson, James, F.G.S., 3 Abbotsford place.	1863
585	Stevenson, John, C.E., 95 Bath st.	1885	Thomson, Jas., LL.D., F.R.S., C.E., Professor of Engineering in the University of Glasgow, 2 Florentine Gardens, Hillhead.	1874
	Stevenson, William, Tower Bank, Lenzie.	1870	Thomson, James R., Clydebank, Dumbartonshire.	1863
590	Stewart, David, 3 Clifton place.	1856	620 Thomson, John, Alliance Foundry.	1876
	Stewart, Henry, City Saw Mills.	1876	Thomson, Jonathan, 136 W. George street.	1869
	Stewart, James Reid, 30 Oswald street.	1845	Thomson, Sir William, LL.D., D.C.L., F.R.S., L. & E., Professor of Natural Philosophy, University of Glasgow, Hon. Vice-President.	1846
595	Stewart, John, Western Saw Mills,	1877	Thomson, Wm., Thornliebank.	1883
	Steuart, Walter, 12 Pollok road, Pollokshaws.	1883	Townsend, Joseph, 13 Crawford st., Port-Dundas.	1856
	Stewart, William, 175 St. Vincent street.	1869	625 *Tullis, James Thomson, Anchorage, Burnside, Rutherglen.	1883
	Stuart, J. Watson, 88 St. Vincent street.	1881	Turnbull, John, 37 West George st.	1843
	Stirton, James, M.D., F.L.S., 5 Newton terrace.	1876	Turnbull, John, Jun., 255 Bath st.	1883
600	Stobo, Thomas, 12 Sardinia terrace, Hillhead.	1884	Turner, George A., M.D., 1 Clifton place, Sauchiehall street.	1883
	Stoddart, James Edward, 60 Robertson street.	1872	Turner, William, 33 Renfield st.	1875
	Storer, David, 5 Billiter Avenue, London, E.C.	1869	630 Ure, John, Crown Mills, 68 Washington street.	1856
	Storer, James, 48 French street, Bridgeton.	1875	Urie, John, 83 Jamaica street.	1876
	Strain, John, C.E., 154 West George street.	1876	Verel, Wm. A., The Linn, Cathcart.	1883
605	Sturrock, David, I.A., 95 Bath street.	1881	Waddell, Matthew, 60 Union st.	1880
	*Sutherland, David, 11 Clarinda ter., Pollokshields.	1880	Walker, Adam, 35 Elmbank crea.	1880
	*Sutherland, John, 11 Clarinda ter., Pollokshields.	1880	635 *Walker, Archibald, B.A. (Oxon.), F.C.S., 8 Crown ter., Dowanhill.	1885
	Sutherland, J. R., 5 Westercraigs, Dennistoun.	1884	Walker, George, 138 West George street.	1881
	Sutherland, Thos., 112 Glebe st.	1886	Walker, James A., 112 St. Vincent street.	1884
610	Swanson, John, 47 Melville street, Pollokshields.	1872	Walker, Malcolm M'N., F.R.A.S., 45 Clyde place.	1853
	Tatlock, John, F.I.C., 100 Sauchiehall street.	1875	Wallace, Abraham, M.D., 4 Newton place.	1877
	Tatlock, Robt. R., F.R.S.E., F.I.C., F.C.S., 138 Bath street.	1868	640 *Wallace, Hugh, Mansfield, Kilmalcolm.	1879
	Taylor, Benjamin, 10 Derby cres., Kelvininside.	1872	Wallace, Wm., Ph.D., F.R.S.E., F.I.C., F.C.S., 138 Bath street, Hon. Vice-President.	1851
	Teacher, Adam, 14 St. Enoch square.	1868	Wardlaw, Johnston, 83 Taylor st.	1884
	Tennant, Sir Charles, St. Rollox Chemical Works.	1868	Watson, Archibald, 29 Elmbank crescent.	1881
	Tennant, Gavin P., M.D., 159 Bath street.	1875	Watson, James, Cluniter, Innellan.	1873
	Terrace, David, Dawsholm Gas-works, Maryhill.	1883	645 Watson, Joseph, 225 West George street.	1882
	Thomson, David, I.A., F.R.I.B.A., 116 St. Vincent street.	1869	*Watson, Thomas Lennox, I.A., 108 W. Regent street.	1876
	Thomson, George C., 39 Kersland terrace.	1883	*Watson, William Renny, 16 Woodlands terrace.	1870
615	Thomson, Gilbert, M.A., C.E., 75 St. George's place.	1885		

Wells, Andw., 8 Newton terrace.	1878	*Wingate, John B., 7 Crown terrace, Dowanhill.	1881
Welsh, Thos. M., 51 St. Vincent crescent.	1883	670 Wingate, P., 14 Westbourne ter.	1872
650 Wenley, James A., Bank of Scot- land, Edinburgh.	1870	Wingate, Walter E., 4 Bowmont terrace.	1880
Westlands, Robert, 99 Mitchell st.	1869	Wood, James, M.A., Glasgow Academy.	1885
White, Adam, Sudbrooke, Pollok- shields.	1881	Wood, J. Muir, 42 Buchanan st.	1850
White, John, Scotstoun mills, Partick.	1875	Wood, Wm. Copland, Turkey-red Works, Alexandria.	1883
Whitelaw, Alex., 87 Sydney st.	1855	675 Woodburn, J. Cowan, M.D., 197 Bath street.	1869
655* Whitson, Jas., M.D., F.F.P.& S.G., 13 Somerset place.	1882	Woodburn, W. S., L.D.S., Lecturer on Mechanical Dentistry, Ander- son's College, 17 Carlton place.	1881
Whytlaw, Robert A., 1 Windsor quadrant, Kelvinside.	1885	Wyper, James, 83 Queen Margaret crescent, Hamilton drive.	1878
Whytlaw, R. A., Jun., 1 Windsor quadrant, Kelvinside.	1884	Yellowlees, D., M.D., Medical Superintendent, Gartnavel.	1881
Williamson, John, 189 St. Vincent street.	1881	Young, George Christie, City Saw Mills, Port-Dundas.	1884
Wilson, Alex., Hydepark Foundry, 54 Finnieston street.	1874	680 Young, John, Kincaid house, Milton of Campsie.	1885
660 Wilson, Alex. S., M.A., B.Sc., Pro- fessor of Botany, Anderson's College.	1880	Young, John, 234 Parliamentary road.	1881
Wilson, Charles, 4 Craigpark, Den- nistoun.	1875	Young, R. Bruce, M.A., M.B.C.M., University.	1885
Wilson, Daniel, 124 Bothwell st.	1872	Young, Robert, 25 St. Vincent crescent.	1875
Wilson, David, Carbeth, by Killearn.	1850	*Young, Thos. Graham, 19 Burnbank gardens.	1880
Wilson, John, 11 Woodside place.	1873	685 Younger, George, 166 Ingram st.	1847
665 Wilson, Peter M'Gregor, Rosevale, Bearsden.	1877	Zinkeisen, Victor, 30 Cochrane st.	1881
Wilson, William, Virginia build- ings.	1881		
Wilson, W. H., 45 Hope street.	1881		
Wingate, Arthur, 6 Kelvin drive.	1882		

THE PHILOSOPHICAL SOCIETY OF GLASGOW.

INVENTORY of all the Property (except the Library) possessed by the Society—made by the Treasurer in compliance with Article XI. of the Articles of Association, and presented to the Annual Meeting on 18th November, 1885.

I.—ITEMS, THE EXCLUSIVE PROPERTY OF THE SOCIETY.

All as in detailed Inventory of last year, printed on pp. 405-6 of the *Proceedings*, 1884-85, vol. xvi., with the following additions:—

READING ROOM.	COUNCIL ROOM— <i>Continued.</i>
Pedestal for Model of Cleopatra's Needle.	Illuminated List of Presidents, framed and glazed. Map of Africa.
COUNCIL ROOM.	
Lithographed portrait of Dr. M'Kendrick, framed and glazed.	SECRETARY. Cyclostyle Apparatus.

II.—ITEMS, THE PROPERTY OF THE SOCIETY JOINTLY WITH THE “INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.”

All as in detailed Inventory of last year, printed on pp. 406-7 of the *Proceedings*, 1884-85, vol. xvi., with the following additions:—

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Mahogany Reading Stand.	Japanned Box for Papers.

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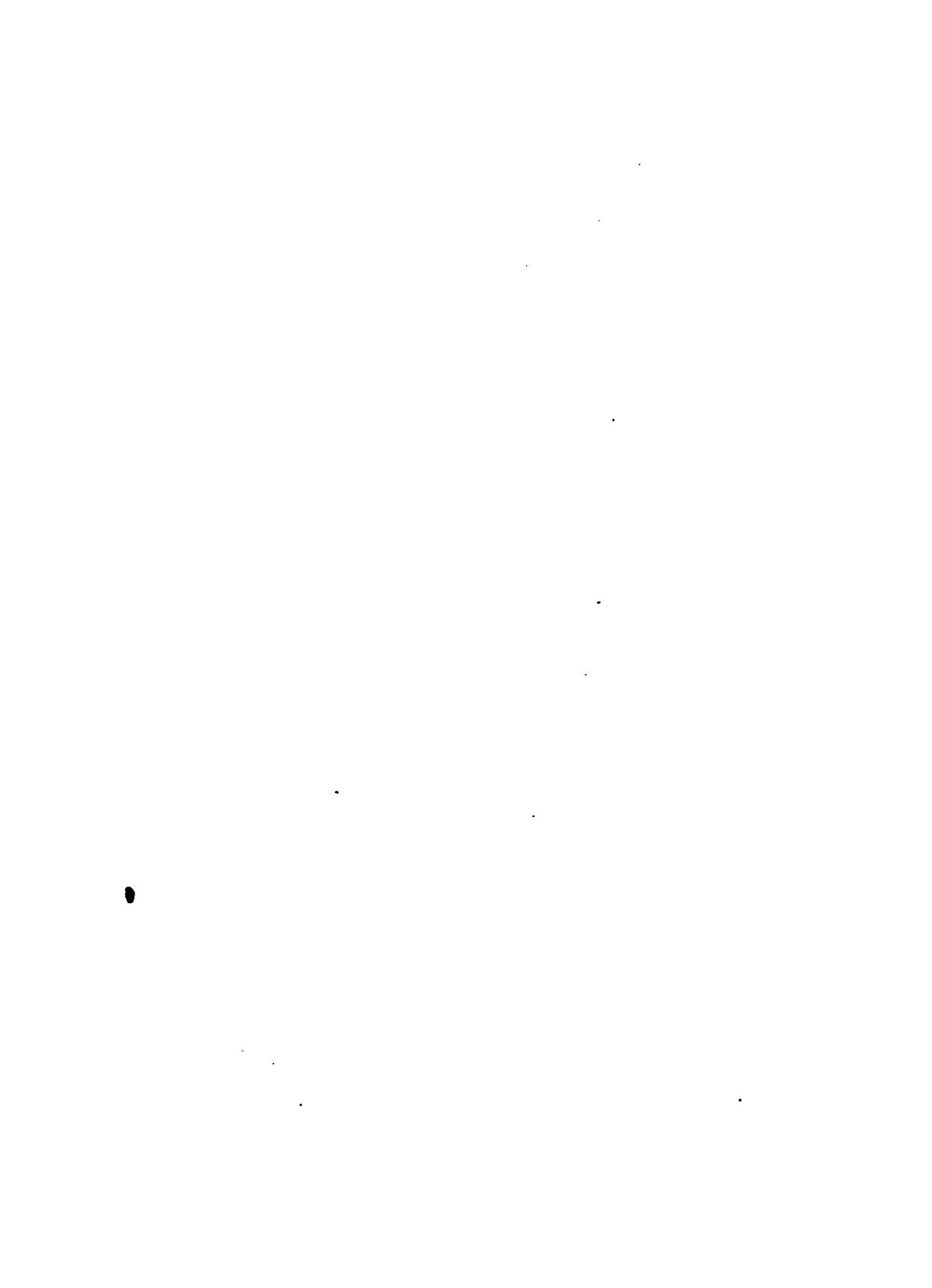
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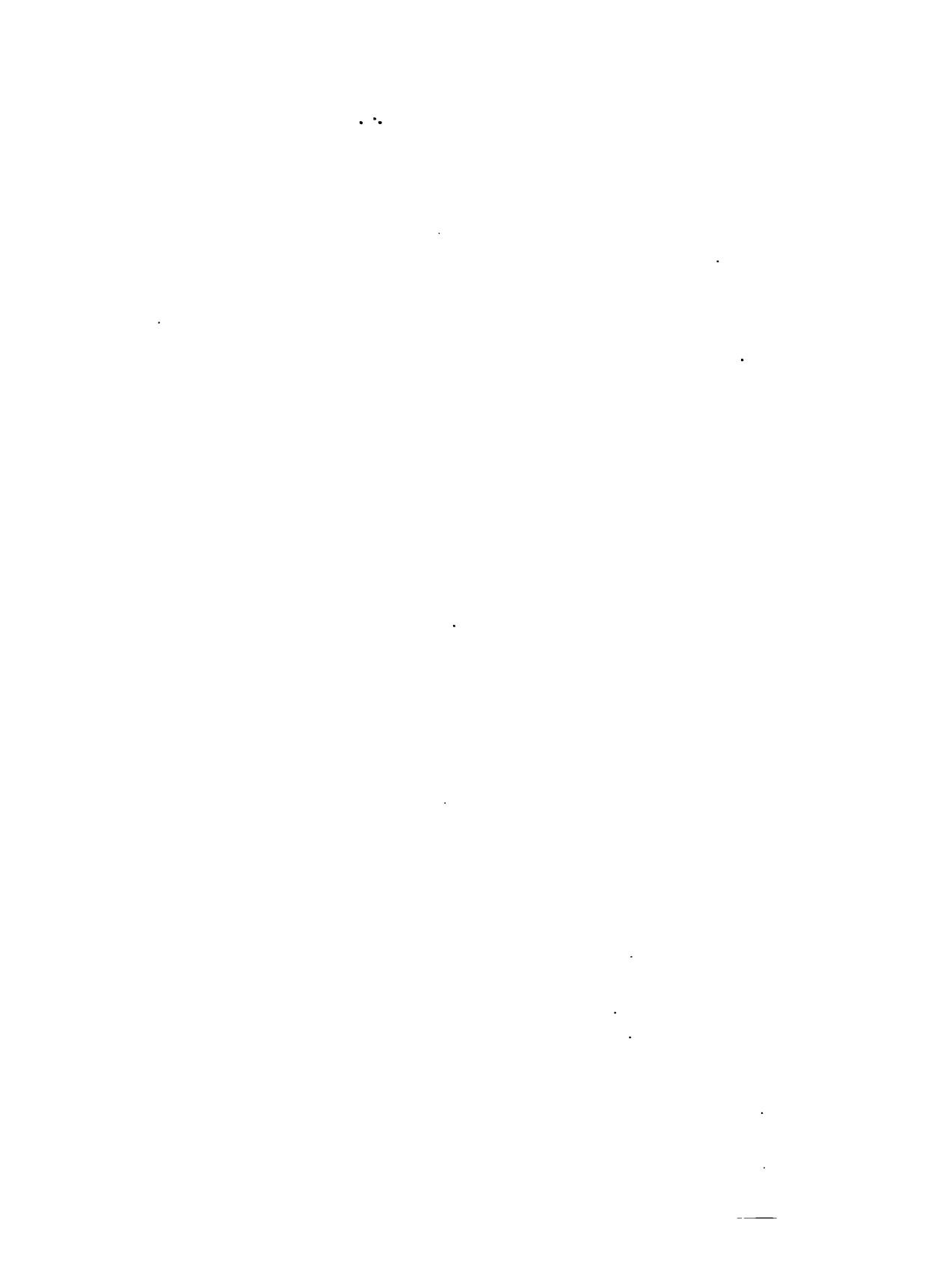
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